PSYCHOLOGY OF HIGH SCHOOL SUBJECTS

JUDD

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PREFACE

It is more difficult to prepare a book on applied science than to write a book on pure science. Applied science touches so many fields of thought and action that there are twenty critics ready to point out difficulties where only one would appear against a volume on pure science. In the following pages I have been guilty of excursions into the territory of the teacher of English, into the stronghold of Latin, into the newly established domains of science and manual arts. I have made observations in these various quarters from the point of view of the psychologist. Many of these observations will be looked upon by my colleagues in psychology as unpsychological; many will be regarded by specialists in English, Latin, science, and the manual arts as biased and ill-advised. It is the fate of anyone who attempts to contribute to applied science to draw upon himself abundant criticism.

The only opportunity which one has of making a remark of a purely personal type being in the preface, I am constrained to point out that it is not at all unlikely that many of the specialists who will say that I ought to keep within the bounds of my own field will unhesitatingly talk in psychological terms which they cannot justify. It would be easy to point to cases where psychology has been used but not applied, where the name of the science of education has been set up as a defense by those who are altogether unscientific.

Fortunately, however, the time has arrived when education is to be put on a broad, objective foundation. The

numerous books on high-school education which have preceded this show that personal views are soon to be set aside in favor of more general and well-established principles. Whoever is able to state in an objective way the grounds of his beliefs about secondary-school problems has a right to speak, and to hope that the criticism which he receives will be directed toward his methods and his formulation of problems rather than toward his special views. It is in this hope that the following pages are offered.

It would be difficult to acknowledge the contributions which have been made directly and indirectly to this volume. Some years ago the author acted as inspector of high schools for the state board of education in Connecticut and came into close and instructive contact with Secretary Hine and others who were engaged in developing secondary education in that state. For the past six years he has profited greatly from intimate association with Principal F. W. Johnson and the other members of the faculty of the high school conducted as a laboratory school in the School of Education of The University of Chicago. During the last four years he has learned much from a group of principals of high schools in and about Chicago who have admitted him each month to the informal meetings at which they canvass without restraint the problems of high-school teaching and organization. To all these the author is under special obligation. To the students who have been members of the classes in which this book has been gradually put in form the author's obligations are larger than he is able adequately to acknowledge. The reports which have been handed in by members of these classes have been full of fruitful suggestions. Many other obligations of a less personal type are indicated by footnotes in the text.

C. H. J.

CHICAGO, ILLINOIS

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CHAPTER I

INTRODUCTION

The Study of Students' Capacities

It would undoubtedly be easy to secure unanimous assent to the general assertion that the teacher ought to understand the mental processes of his students. Every beginner's book in Latin or German, every volume of selected source material in history, every carefully formulated introductory textbook in science, is concrete evidence that the student as well as the subject to be taught is part of the teacher's problem. If we attempt to push the argument beyond this general suggestion, however, and insist that every high-school teacher should take courses which deal with the mental processes of his students, we encounter a wall of objections. We are told that what teachers need is a more complete knowledge of the subjects they teach, that it is distracting and irrelevant to spend time on the study of mental processes. It is confidently affirmed that the teacher will in any case get some acquaintance with human nature through classroom experience; roundabout, labored, theoretical studies are therefore declared to be wasteful and unproductive. Finally, one hears the statement that students who are of the maturity of young people in high school ought to be able to

understand anything that is presented logically and clearly; it is therefore better that the teacher should think of orderly organization of subject matter rather than devote time and attention to the study of students' mental processes.

These objections to the study of the mental processes of students have grown stronger in the minds of teachers and laymen because psychology has been slow to point out the applications of its principles to the work of the high school. Psychology has been a general and somewhat abstract description of mental life. For example, since the time of Aristotle psychologists have taught the laws of memory, but until recently no one has thought it important to study in detail the most economical methods of memorizing, and no one has made a careful analysis of the ways in which the general laws of memory manifest themselves in the special fields of historical and mathematical study. Again, psychology has had much to say about the perception of space, but little has been worked out regarding the mental processes involved in the study of geometry, which is based on space perception, and little has been written on the relation of courses in drawing to space perception. Finally, psychology has taught that mental development is a gradual process exhibiting stages which differ in the quantity and probably in the quality of the intellectual processes exhibited, but few writers have attempted to tell us how the fourteen-year-old boy differs in his train of ideas from the boy just ready to graduate from the high school at eighteen years of age. In short, we have been without a thoroughgoing application of even the most generally accepted principles of psychology.

After assuming, in behalf of the science of psychology, a due share of responsibility for this neglect of applications, it is just to call attention to the fact that, in a very proper sense of the word, psychology cannot be charged

with the task of applying its principles. Applications vary with different situations and must be worked out by many minds. The same is true in the domain of physical science. Many and diverse are the situations which arise in industry and art. Just as the science of physics remains seemingly abstract and general until the manifold applications of mechanical laws are worked out by a thousand practical inventors, so the science of psychology can never, as a science, demonstrate its usefulness until many workers apply its general laws to concrete cases.

Social Necessity of Studying Students

Fortunately for educational psychology there are social forces at work which are making necessary a careful study of the mental processes of high-school students. However reluctant teachers and supervisors may be to turn away from subject matter, however large their confidence in classroom experience, the urgent problems of secondary education are calling for new insights and new wisdom; and psychological methods of studying these problems are being called into service on every hand more rapidly than these methods can be refined by careful, technical study. We find ourselves, accordingly, in the curious situation of listening to vehement objections to the study of psychology, while at the same time we observe social forces compelling a movement in the direction of the study of educational problems by psychological methods.

Thus the sudden enrichment of the course of study has so disturbed the quiet satisfaction with which the older subjects, such as foreign languages and mathematics, consumed the time of students that no department feels any security about its place on the program. Latin, seeing the sudden end of Greek, its sometime companion in aristocratic supremacy, has cultivated the fluent use of a formidable

psychological vocabulary, and one hears the teacher of this ancient and respected tongue contending that Latin cultivates the constructive imagination, gives the student training in comparison and generalization, and develops the power of expression.[1] In like spirit the teacher of algebra confesses that his subject has in the past been somewhat abstract, but he promises to eliminate the most objectionable and formal parts of the subject and to amplify those parts which will aid the student in concise, accurate, and summary treatment of the quantitative aspects of nature.[2] The newer subjects are exultant in a formula which they believe that the psychologist has supplied them, and fall upon the older members of the course of study with the statement that the dogma of formal discipline is to be replaced by the doctrine of specific training.[3] Since there is no more formal discipline, the argument runs, there ought to be infinite variety in the course of study.

The psychologist, who has traditionally been a person of the most abstract temper, observes with interest that he has become a party to the struggle for place in the high-school program. He may be permitted to wonder why the destructive psychologists who attack formal discipline are quoted so freely by the newer subjects, and the constructive psychologist who has developed a positive doctrine of general habits[4] has to wait for the gradual spread of interest in psychology before he can be heard. It seems at times that education is moving in the direction of a study of applications of psychology, but moving somewhat obliquely.

[1] F. W. Kelsey and others, Latin and Greek in American Education, p. 21. The Macmillan Company, 1911.

[2] Arthur Schultze, The Teaching of Mathematics in Secondary Schools, p. 292. The Macmillan Company, 1912.

[3] C. R. Mann, The Teaching of Physics, pp. 170 ff. The Macmillan Company, 1912.

[4] S. S. Colvin, The Learning Process, chaps. xiv, xvi. The Macmillan Company, 1911.

Urgent Demands for Efficiency and Economy

Again, social forces are pushing in the direction of psychological studies because in these days there is a widespread interest in efficiency and economy. One may scoff at this interest and dub it mercenary and groveling if he likes, but the time has passed when the public will pay for a school which has no justification for its being other than that it fills up the leisure of its students. Indeed, systems of training are open to criticism, even though they are thought to be working along right lines, if their work is done clumsily and to less than the maximum effect. It is no longer accepted as a mere academic discussion when it is reported that the English instruction given in high schools and colleges is inefficient.[1] English has been generously dealt with in the course of study in recent years. When it is found that students cannot write and do not read, the question arises very pointedly, What is the matter? One finds the English teachers organizing and discussing the natural tendency toward dramatization,[2] the contrast in effectiveness between oral and written expression, and the literary preferences of different stages of adolescent development. When the English teachers take up such matters as these, the psychologist rejoices to note that a wider currency is being given to a type of consideration which he developed at a time when teachers of English and science and mathematics were absorbed in their subjects and regarded the psychological jargon as of little value. Even the layman is beginning to interest himself in these detailed discussions. Surveys are organized to find out whether school moneys are well spent and whether the time of boys and girls is

[1] *The English Journal*, 1913, Vol. II, pp. 58, 416, 575.

[2] Percival Chubb, The Teaching of English, pp. 53, 187, 235 ff., 275, The Macmillan Company, 1909. G. R. Carpenter, F. T. Baker, and F. N. Scott, The Teaching of English in the Elementary and the Secondary School, pp. 99, 255, 276, Longmans, Green, & Co., 1913.

properly conserved. The methods of these surveys turn out to be, in many cases, psychological. The psychologist is finding in the school surveys an opportunity to carry out on a large scale tests which a few years ago he proposed in vain as purely psychological studies.

Recognition of Individual Differences

Another problem which has come to be an urgent social problem is that of individual differences. The time was when a boy or girl was assigned a station in life in terms of the father's achievements in the world. To-day a new order is being evolved. Society is finding that its tasks are most efficiently performed by those who are best suited through native and acquired interests to certain particular kinds of work. The whole school system beyond the first six years of the elementary school recognizes clearly the principle of differentiation, and is absorbed in studying individual variations so as to provide adequately for the different natures and interests of students. Here again the psychologist recognizes a familiar type of study. Centuries ago Descartes distinguished between different temperaments. He used the terms which the medieval physicians had employed, and called attention to the differences between the phlegmatic, or slow, individual and the quick, sanguine type of mind. He pointed out that some are hot-tempered or choleric and others sad or melancholic. The present-day psychologist is not satisfied with this general classification, but the reference to Descartes shows that he follows the lead of the founders of his science in calling attention to the fundamental differences in personality exhibited by high-school students.

In 1883 Sir Francis Galton[1] made a notable modern contribution to the study of individual differences. He

[1] Inquiries into Human Faculty.

found that certain persons recall in vivid detail anything they have seen. Such persons he called visualizers. They remember the colors of objects and recall fully and accurately the positions of things. On the other hand, there are many who have only faint, blurred visual images. The work of Galton has been quoted again and again by those who would justify this or that educational practice. More recently several students of psychology, notably Thorndike[1] and Hall,[2] have developed the doctrine of individual differences in an extreme form. The advocates of various innovations, such as vocational education and special courses for girls, have seized on these studies with the greatest avidity.

General and Special Studies of Psychology

Such examples encourage the psychologist to believe that the time is ripe to essay the comprehensive task of applying his science to all high-school problems. This general application has been attempted from one point of view by that pioneer in educational psychology, G. Stanley Hall. Hall undertook to give a description of the mental characteristics of the adolescent period. So elaborate is his description that it frequently becomes highly speculative and fantastic, but the outcome is a keen awareness on the part of high-school teachers that adolescent mental processes are not like those of earlier childhood and not like those of adult life. This recognition of the special characteristics of the adolescent mind turns out, however, to be only of general value to the individual teacher in his daily task of training students. The teacher's special instrument of instruction is the particular subject matter which engages both his

[1] E. L. Thorndike, Educational Psychology, Vol. III. Teachers College, 1913.

[2] G. S. Hall, Adolescence, Vols. I and II. D. Appleton and Company, 1905.

thought and that of the student. The general facts about the period of adolescence do not determine what should be done in these particular courses. Would it not be more productive to take up one after another the subjects of instruction and inquire what are the mental reactions typical in each? General psychology and the special psychology of adolescence would thus be focused on the day's task. To be sure, there will appear in the successive chapters of such a psychology of high-school subjects the clearest evidence that there are general temperamental traits, general habits of visualization, general laws of memory, and all the rest, but these generalizations will not be the chief matters of investigation. It is the special mathematical idea generated in grasping an algebraical formula which the teacher of mathematics must control. It is the special recognition of the Latin form which is important to the teacher of the classics. General principles will not satisfy these specific needs.

The preceding paragraph may leave in the mind of the reader the impression that each teacher is to be urged to study only the psychology of his own specialty. It must be admitted that even so much knowledge of applied psychology as would be represented by a chapter on the psychology of a single subject would be a real addition to the equipment of most high-school teachers. But one should not confuse this plea for a little psychology with the final purpose of the psychologist. Applied psychology will advance most rapidly if it is subdivided to conform to the teacher's special needs and interests, but the science will not be complete until a synthetic comparison is made of the results of these special chapters. Such a comparison is necessary in order to show clearly the meaning of statements like the following: Algebra is abstract and theoretical; manual training is concrete and practical. The algebra teacher must ultimately know what is meant by concrete and practical; the

manual-training teacher must know what it means when we assert that some subjects in the curriculum are abstract. To a plea for the cultivation of special psychological studies in each field may therefore be added an equally urgent plea for a comprehensive study of the psychology of all fields. One of the gravest menaces to the unity of educational institutions to-day is the lack of common interests on the part of special teachers. Their natural, common interest is, of course, the student. If the effect upon the student of a course in English is to make him more appreciative of emotional experiences, what effect will this have upon his interest in geometry? The psychology of the special subjects will thus merge into the psychology of the student; but the investigation is introduced by a treatment of specific, practical problems and is brought gradually up to the more general considerations.

Typical Problems for Special Study

In order to show that specific problems are the natural starting points of the study, let us anticipate later discussions by referring to one or two urgent special questions. One hears the teacher of science, for example, advocating the use of drawings in the notebooks of students. If the question is raised whether all kinds of drawing contribute to clearness of scientific thought, one is likely to get an answer from the uncritical teacher which is too inclusive. As a matter of fact, only analytical drawing is of value in science work; general sketches are often worse than useless in cultivating scientific observation. This example gives us the opportunity to dwell on the moral that teachers of science should clear up their psychology of drawing. They have a vague idea about drawing and about the way in which it affects mental life, but they seldom subject this vague notion to adequate, scientific criticism.

The teacher of languages writes in a large, loose way that pronunciation of a foreign language is important because it contributes to the student's sensory and motor experience.[1] The more sensory material the student gets, the more vivid and lasting his experiences; the more the motor organs are exercised, the more permanent the effect of impression. If these statements are true, they are important for the teacher. If they are not true, or if they need to be qualified in any degree, the teacher of language will be helped by a substitution of exact, scientific statements for the indefinite beliefs with which he started.

How shall definite, exact statements be substituted for present vague ideas on the psychology of high-school subjects? It would, needless to say, be a source of large satisfaction to the writer if he could answer this question by saying: Read the following chapters and you will be in the presence of an exact science. In the interests of candor, it must be said that the goal is not reached. This volume is an effort to open up as many questions as possible, to summarize definite knowledge where such exists, and to suggest to high-school teachers the methods which they may adopt in carrying on this type of study.

Methods of collecting Psychological Material

The writer has found it very productive for himself and for his students to take in hand some one of the books on the teaching of a specific high-school subject or some textbook designed for classroom use, and to read these with the idea of discovering the psychological principles which the author had in mind, often very vaguely. Conversely, it is interesting and profitable to assume the attitude of a teacher of mathematics or history and to read some general

[1] C. H. Handschin, "On Methods of Teaching Modern Languages," *Science*, April 18, 1913, *N.S.*, Vol. XXXVII, p. 600.

book on psychology for the sake of extracting those psychological principles which can be applied to the special subject. Such readings, undertaken with a highly specialized purpose, raise many interesting and important questions for the student of high-school problems.

Once a question is raised, the answer can be sought through systematic observation, including experimentation. Systematic observation has for the most part been lacking in school work. For example, teachers visit other schools than their own for the sake of observing. On arrival in the strange school, the visitor finds himself absorbed in the material equipment, in the textbook, in the appearance of the students, in the personality of the teacher, and in a host of other externals. The hour passes without any definite concentration of observation on any single problem. The case is often quite as bad when one tries to observe his own students while he tries, at the same time, to do his duty as a teacher. The effort to keep the class moving and the urgency of the sheer social situation in the classroom are so engrossing that the teacher finds the hour past and no psychological observations completed. In the midst of such distractions the teacher must learn two maxims of scientific method: first, select one definite point on which to make observations; and second, make these observations deliberately for a sufficient period of time to reach some conclusions. Accessory devices are valuable, such as keeping records and setting up experimental conditions. Thus, in the matter of drawing in the science class, keep the drawings and compare them with the rest of the work of each individual. In the matter of pronunciation of a foreign language, have one class which emphasizes pronunciation and another which does not, keeping the other conditions, so far as possible, alike. If teachers could be induced to begin systematic observations in their special lines and to report their findings, the science of educational psychology would flourish.

Indeed, it is hopeless for the teacher of psychology to undertake single-handed to do much toward developing a science of applied psychology. He can raise questions and formulate suggestions, but the applications, as indicated above, must be worked out and refined by many workers. In the past, individual teachers have doubtless reached many definite and well-supported conclusions, but these have been, for the most part, lost because there was no effort to collect and record them. To-day the teaching profession is working more and more as a unit, and the time is at hand when agencies will be developed for bringing together the scattered findings of many observers. It is the purpose of the following studies to contribute to this end. Even disagreement with the conclusions reached can be accepted as promoting the purposes of the book, provided these disagreements are supported by observations.

Exact Measurement and Scientific Analysis

There is one discussion upon which it is appropriate to touch at this time, in order to create in the minds of teachers a proper conception of scientific method. An acrimonious dispute has been carried on in some quarters between practical school people and the so-called scientific experts regarding the possibility of measuring school activities and evaluating results of teaching in a rigid, scientific way. The expert calls for exact comparisons with standards and for tables which show quantitatively how far these standards are reached. The individual student and the individual teacher seem to many to be left out of consideration in these strenuous efforts to attain exactness and a high degree of generality. Many a teacher is alienated, and refuses to become a party to scientific study of education because he does not sympathize with the expert's demands for rigid, scientific exactness.

The writer of these pages is an advocate of exactness and of rigid, scientific formulation of results, but he is also an advocate of direct, analytical studies of individual cases. He believes it is possible to reconcile these two types of study so that the strict, scientific character of each shall be apparent.

After all, what is sought in scientific studies of education is a thorough understanding of each situation which arises. Take the case of a boy who is about to leave school. The teacher may let the boy go without making any effort to study his case, or may try to find out about the boy's home conditions, about his expectations of employment, about the boy's success or failure in his studies, and the reason for failure if this is one of the causes of withdrawal. Such a study of a single boy may be most productive. The difficulty with such a study of a single case is that the teacher is not likely, without contact with other cases, to know how to attack the problem. For example, let us suppose that the boy says that his family needs the money he can earn. Perhaps this is merely an excuse that the boy offers himself and his friends, not the real cause of withdrawal. If the teacher has at hand a whole series of cases which have been analyzed on the side of their economic urgency, he will have standards of economic needs by which he can determine whether this boy really is forced to withdraw or is merely falling into this device of justifying his act. Furthermore, if the teacher can show by the study of many cases that there is a constant tendency in boys of a certain type and age to become interested in occupations, even when there is no economic stress, he will see in this particular boy the operation of a general principle. The teacher will come to realize that this one boy's act is an indication that the whole school situation needs to be looked into. Perhaps what is needed is not a reform of the boy, but a reform of the course of study. This example

shows that the individual teacher needs to have his horizon extended by general studies in order that his particular observations may be understood in their true perspective.

Arbitrary Standards and Scientific Standards

Take another type of illustration. The teacher of science in a high school has in mind certain standards which he regards as representing the legitimate requirements to impose upon his students. The students should be able, he thinks, to reason, to apply their mathematics, and to look up information in the library. Several students in the class cannot do this, and he warns them or puts them out. The rest of the class struggles through the course and never elects any more science work. The teacher takes great pride in his high standard and strong handling of the class. Very often he has been wrong in his views about students; he has been arbitrary and wholly unscientific in his behavior. If he is a keen observer and of an adaptable temperament, he will gradually change his methods, and will, with increasing experience, ultimately reach a standard which will be a compromise between the arbitrary standard with which he started and the real needs of his students. This slow readjustment could have been greatly facilitated if the teacher had at the outset investigated his students by some of the tests which are being developed in every subject. A test is a means of informing an instructor what students of a certain degree of maturity can do. The kind of work which in the long run is best for the school is not determined by a consideration exclusively of the subject to be taught. The students in one class should be compared with students of other schools and of other degrees of maturity. The trouble with many a teacher, especially when he first begins to teach, is that he does not have a knowledge of students adequate to give him proper standards of judgment. Standards of judgment are

matters of comparative experience, and they must be set up through observation and comparison of many cases.

The demands for general standards sometimes discourage teachers, because they realize that the individual teacher often has no opportunity to make comparisons on a large scale. There are two considerations which may help to remove this natural discouragement. First, standards are being developed through coöperative activity and are becoming each year more easily accessible. If teachers will coöperate in working out these standards and will examine the work done along these lines, there will shortly be no lack of comparative material usable by all. Second, and more important, is the fact that the establishment of general standards is only one phase of scientific study. Standards are valuable only when they aid in producing discriminating analyses of individual cases. Here is a boy who is failing in algebra. General standards help to suggest various ways of determining the facts in this case, and the combined experience of algebra teachers would, if known, undoubtedly suggest possible explanations of the individual's difficulties. But after all is done and said, this individual case must be analyzed as an individual case. In its totality it is not like any other in the world. That teacher is truly scientific who sits down with all the experience and suggestions he can gather and focuses these on this individual case. What this particular boy needs is perhaps guidance in how to study, or he may need to be given an outlook into his own future possibilities, or he may need to go back and review something essential which he missed, or he may need more physical exercise. Whatever he needs, he is a case to be diagnosed by a trained analyst. Science in its applications is here seen to assume the form of analysis.

Individual teachers are scientific when they acquire the ability to analyze individual cases. They will usually be

most successful in analyzing individual cases if they work in the light of general experiences. The teaching profession becomes scientific when it creates a body of general standards and principles of analysis which will help the individual teacher in making individual diagnoses. The science of education is general, comprehensive, inclusive; the scientific work of the trained teacher who applies scientific principles must be both comprehensive and penetrating, both general and analytic. Between the two demands there is no opposition. The keen analysis of the individual teacher will aid the comprehensive science; the comprehensive study will give the individual teacher the instruments of analysis. There are many cases in which the general science and the experience of the individual teacher will not cover with equal completeness some urgent, concrete school problem. We shall then have to get on by the best guessing of which we are capable. If, however, we have the true scientific spirit, guessing will be followed by a careful criticism of the outcome. Even here, where we are forced to act without the guidance of science, we can turn the case to the advantage of science by following up our results.

These comments will serve to illustrate what is meant by the statement made some paragraphs back that all careful, systematic studies of school problems are scientific. There need be no lack of coöperation between the scientist and the practical teacher. There need be no aloofness on the part of teachers. Our science of applied psychology is in the making — any real experience will contribute to its development. In what degree this is true in the domain of high-school teaching the following chapters will aim to demonstrate.

CHAPTER II

PSYCHOLOGICAL PROBLEMS IN MATHEMATICS

Mathematics is the best subject with which to open our studies. In the first place, the practical difficulties which arise in teaching mathematics bring the courses in this subject constantly to the attention of all who are interested in the development of the high school. In the second place, psychology is better equipped to discuss mathematics than it is to deal with any other school subject, because the psychology of space perception which throws light on geometry, and the psychology of abstraction which throws light on algebra, are among the most complete and satisfactory chapters in psychology.

In dealing with mathematics it will be possible to illustrate a number of general methods and typical conclusions. The reader of these early chapters should be prepared, therefore, to carry forward many of the discussions to later subjects, keeping in mind the comment made in the introductory chapter that the psychology of high-school subjects is a general science, not merely a series of isolated chapters on particular subjects.

THE PSYCHOLOGY OF FAILURES

Mathematics must be recognized as one of the most difficult subjects in the high-school course. The following table gives, in a vivid way, evidence in support of this statement. It shows the failures and withdrawals in eleven suburban high schools surrounding Chicago and reveals a condition which is doubtless typical.

	Number of Pupils enrolled	Number of Pupils with-drawn	Number of Pupils failed	Percent-age with-drawn	Percent-age failed	Total Loss
English I	1075	98	109	9.1	9.4	18.5
English II	723	57	63	7.9	8.7	16.6
English III	627	41	49	6.5	7.8	14.3
English IV	422	28	20	6.6	4.7	11.3
Total	2,847	224	241	7.9	8.5	16.4
Algebra I	914	118	157	12.9	17.2	30.1
Algebra II	386	54	44	14.0	11.4	25.4
Plane geometry	397	61	74	15.4	18.6	34.0
Solid geometry	74	7	4	9.5	5.4	14.9
Trigonometry	73	7	3	9.6	4.1	13.7
Latin I	660	98	71	14.9	10.8	25.7
Latin II	470	34	51	7.2	10.9	18.1
Latin III	188	10	7	5.3	3.7	9.0
Latin IV	82	1	1	1.2	1.2	2.4
German I	402	51	49	12.7	12.2	24.9
German II	249	17	11	6.8	4.4	11.2
German III	119	11	1	9.3	.8	10.1
German IV	10	0	0	0	0	0
French I	238	20	18	9.4	7.6	17.0
French II	102	8	2	7.8	2.0	9.8
French III	25	0	0	0	0	0
Spanish I	12	4	0	33.3	0	33.3
Ancient history	836	109	97	13.0	11.6	24.6
Med. and mod. history	385	45	31	11.7	8.1	19.8
U. S. history	279	23	11	8.3	3.9	12.2
Physics	278	24	15	8.6	5.4	14.0
Physical geography	157	10	26	6.4	16.6	23.0
Botany	278	29	38	10.5	13.7	24.2
Zoölogy	136	26	14	19.2	10.3	29.5
Chemistry	198	31	12	15.7	6.1	21.8
Physiology	360	60	59	16.7	16.4	33.1
Commercial geography	143	18	18	12.6	12.6	25.2
Commercial arithmetic	293	31	45	10.6	15.4	26.0
Bookkeeping	208	26	14	12.5	6.8	19.3
Stenography	215	25	5	11.7	2.3	14.0
Typewriting	128	7	13	5.5	10.2	15.7
Freehand drawing	154	13	0	8.5	0	8.5
Mechanical drawing	218	19	19	8.7	8.7	17.4
Science	127	12	8	9.5	6.3	15.8
Design	233	7	3	3.0	1.3	4.3
Hygiene	20	4	1	20.0	5.0	25.0
Household art	150	22	4	14.7	2.7	17.4
Domestic science I	139	9	4	6.5	2.9	9.4
Domestic science II	116	6	1	5.2	.9	6.1
Manual training (wood)	208	43	10	20.7	4.8	25.5
M. T. (forge foundry)	75	6	3	8.0	4.0	12.0
M. T. (machine shop)	26	1	1	3.9	3.9	7.8
Pottery	45	6	0	11.1	0	11.1
Economics	41	1	3	2.4	7.2	9.6
Civics	56	7	4	12.5	7.2	19.7

NOTE. Quoted from *School Review*, June, 1913, Vol. XXI, p. 415.

The figures given for withdrawals include all who left the course before the examination. Some withdrew for the reason that they were failing, but these were not separated from those who withdrew for reasons unrelated to their scholarship. The significance of withdrawals, as compared with failures, comes out in comparison of different classes. Thus compare English I with Latin I. In many cases the students in English remain in the course and fail rather than withdraw. This is doubtless due in part to the fact that English is required of all students. In Latin, on the other hand, students withdraw after they have tried the course for a short time. The percentage of withdrawals is accordingly greater than the percentage of failures. There is a very surprising percentage of withdrawals in manual training.

The table given above also shows that the mental processes which the mathematics teacher aims to call out are less likely to be called out successfully in the average student than are most of the mental processes with which the high school deals.

Changes in Mathematical Textbooks and Courses

Following this clue of the difficulty of mathematics, we find striking evidences on all sides that the mathematicians have been trying to make their subject easier. The algebra textbook of to-day is a less difficult text than was the book of twenty years ago. In geometry the same process of simplification has been going on. Furthermore, not only have the individual courses been reduced to a minimum, but the requirement of mathematics for graduation and for admission to college has been steadily relaxed. All these facts bear eloquent testimony to the difficulty of the mathematical modes of thought for the average student.

While mathematics has thus been gradually reduced, other questions have naturally arisen. The place of algebra in the first year has been called in question. The experiment has been tried of putting algebra into the second year,

with distinctly better results. It is to be noted that in this experiment the students are somewhat more highly selected because of the withdrawals of the first year, and they have the advantage of other lines of work which have prepared them more fully; but these facts only make it clearer that algebra in the first year is at least open to question.

Historical Grounds for the Position of Geometry

Historical considerations strengthen the suspicion that our high-school mathematics is not well arranged. Nothing is more evident than that algebra is less natural to the occidental mind than geometry. The Greeks had a vast knowledge of geometry and very little knowledge of algebra. The knowledge which the Greeks had of geometry was undoubtedly related to their interest in form and figure. They were a nation of sculptors, and their wise men formulated the science of angles and areas to the point where it could take on that rigid logical formulation which Euclid gave to Greek geometry. While all this interest was being manifested in form and space, nothing of the modern type of algebra was known. Indeed, that the simpler science of numbers was in a most primitive stage, is shown by the clumsy number system evolved by the Greeks and Romans.

Before we turn to the history of the introduction of algebra into Europe, let us see how it came about that geometry gained the place which it holds as a more advanced subject than algebra. One would expect geometry to come early in the school course, in view of the fact that it matured much earlier than algebra. The fact is that its very perfection served to take geometry into the highest schools. In the university of Alexandria the results of Greek studies of space were put into logical form by Euclid. This logical form was also borrowed from Greece, where Aristotle had evolved that perfect system of syllogistic logic which

dominated the whole period of medieval thought. A complete geometry expressed in a perfectly logical form became one of the chief subjects of the highest courses of study. Studies of space were no longer of the primitive type that had grown up among the early Greeks. Teachers in the lower schools have never realized that the union of logic and space studies deprived them of one of their most natural subjects of instruction, namely, form-study. The logical statement of the principles of geometry has blinded modern as well as medieval teachers to the true worth of this subject for younger pupils.

Algebra historically of Secondary Importance

Algebra, on the other hand, was a late comer. This science, like modern arithmetic, came into Europe with the Moors. A little arithmetic had been taught in the lower schools of Rome and medieval Europe to the shopkeepers, who needed it for their accounts, and to the priests, who needed it to compute their calendars. It was not until Europe learned the Arabic numerals that a real science of arithmetic became possible. With the new arithmetic came also a close relative, namely, algebra. Algebra, as a late comer and as a relative of arithmetic, took second place in the universities and high schools as compared with geometry; and second place meant, curiously enough, an earlier place in the course of study, no one having insight enough to raise the psychological question of the true intellectual sequence of the two subjects.

This historical sketch shows how utterly lacking in rational, psychological arrangement has been the school course in mathematics. It is at least thinkable that algebra ought to follow geometry. Indeed, one reads in the books on the teaching of mathematics discussions which suggest that even the mathematicians have at times had guilty

consciences about the matter.[1] To the psychologist who has no interest in following the traditional order of the course of study it seems important to raise a series of psychological questions. Why did the Greeks develop geometry early? Why did the logical form which geometry took on fail to develop in later generations the vivid interest in space and the keen perception of space exhibited by the early Greeks? What is there in algebra and geometry which justifies the classification of the two under the single term "mathematics"? Is the relation between arithmetic and algebra recognized by the ordinary high-school student? If teachers find that arithmetic does not easily carry over into algebra, how was it that arithmetic and algebra were related in their early history when they were not associated with geometry? Are algebra and geometry related in the thought of students? The mere asking of these questions shows how rich is the opportunity for psychological analysis of high-school courses in mathematics.

Interrelation of Algebra and Geometry

Perhaps the most significant psychological questions are those which arise out of the fact that the mathematicians recognize all of the different branches of these sciences as interrelated, while students do not. Descartes showed that algebra and geometry are parts of a single system of thought. What is it that is common to the two subjects? The schools and historical development have kept them apart, and now, in the effort to follow the suggestions of the mathematicians, there is a new and vigorous movement to bring them together.[2] In Europe, especially in England,

[1] A. Schultze, The Teaching of Mathematics in Secondary Schools, p. 289. The Macmillan Company, 1912.

[2] E. H. Moore, "On the Foundations of Mathematics," *School Review*, 1903, Vol. II, p. 521. Numerous references are given to the writings of advocates of combination.

and at several centers in America, combinations of one sort or another have been attempted. If these combinations are to be ultimately successful, they must be based on some clear and explicit principle. This principle must be a psychological principle, for the combination of the two subjects is intended to produce some sort of intellectual advantage to the student. What is this advantage?

The Problem of Application

Another interesting psychological question arises when we consider the problem of applying mathematics to other spheres of thought and action. Experience shows in the most discouraging way that a student may know his algebra and geometry and not know how to apply mathematics to physics or to certain practical shop problems. Evidently one is not performing the same mental process when he masters a mathematical formula and when he uses it. This suggests the study of the psychology of applications.

In seeking answers to the psychological problems which have been stated in the last few pages, we shall begin by summarizing the conclusions which general psychology has reached in its studies of space perception. We shall thus have the advantage, as pointed out above, of being in a field where psychology can speak with a good deal of definiteness.

CHAPTER III

THE PSYCHOLOGY OF SPACE

Space a Complex Form of Experience

Most people who have not studied the character of their space experiences assume that all one needs to do in order to see distance or form is to open his eyes and look. A very little consideration will, however, convince even the superficial observer that this is not true. The ordinary man sees maple trees and elm trees and apple trees, and does not notice that each of these kinds of trees has a characteristically different form. We all of us look at the houses in which we live, but the chances are infinitely large that we do not notice many of the facts of form which come out immediately if we pause for a moment and look with careful discrimination. As for distance, we all know that the judgment of the ordinary person is very crude. Every novice at baseball knows that he has very little power of recognizing distances; and the false estimations which result when one goes from the moist air of the seashore to the dry, clear air of the mountains have been commented on again and again. Furthermore, the sizes of things are constantly misjudged. The house which seems so huge to the little child shrinks into very modest dimensions in the consciousness of the man. The colossal statue disappoints the tourist when he first sees it from a distance. Men and horses seen from a high building fascinate one with their curious littleness.

Perhaps the most striking way of reënforcing these commonplace examples of the fact that space is not seen

by merely opening the eyes is to report a laboratory experiment, which shows how the recognition of a simple form develops through a few repeated observations.

EXPERIMENTAL STUDY OF SPACE PERCEPTION[1]

When a pattern is ten times in succession laid before an observer for ten-second intervals and his successive efforts to reproduce the pattern are compared, there is often very striking evidence of the development which has taken place during the ten drawings, but it is extremely difficult to prepare a table or curve which will adequately demonstrate these facts of development. In order to make clear the character of the results and at the same time illustrate some of the most significant characteristics of the drawing, two series of drawings are reproduced in Fig. 1. These reproductions are one sixteenth the size of the actual drawings. The figure shows two full series from observers F and W. Above the two series of drawings from these observers is shown the pattern which they were trying to reproduce.

Considering series *A*, which is from subject F, certain facts regarding the subject's perceptual development are very evident. The first drawing is correct in general outline, but very vague in its details. The subject has here a percept comparable to that which most persons have of an object which has been observed superficially but not examined in detail. The face of a comparative stranger, for example, or the forms of a plant or wall-paper pattern are first recognized in gross general outline. Drawing II shows progress, in that the details now begin to be correctly reproduced. The first part of the figure has evidently received

[1] C. H. Judd and Donald J, Cowling, "Studies in Perceptual Development," Monograph Supplement No. 34, of the *Psychological Review*, June, 1907, pp. 352–356.

not merely a vague general inspection, but has been examined in detail. The slow rate at which the details of a percept are recognized is here strikingly illustrated, in the

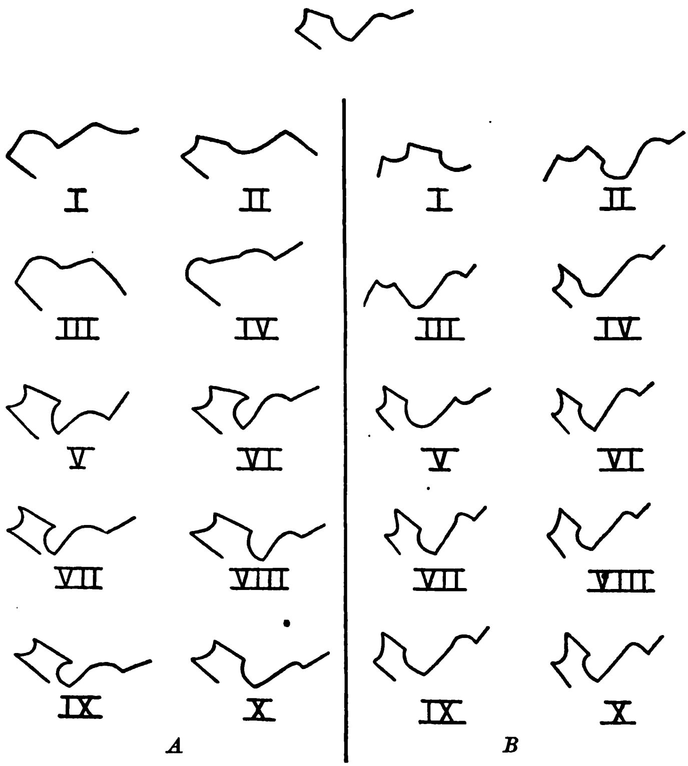


Fig. 1

fact that an adult who is perfectly familiar with lines of this character does not succeed in ten seconds in clearing up more than five lines. Furthermore, the fourth and fifth lines are sufficiently different from the pattern to be recognized as rough approximations rather than fully recognized

details. The general form of the figure is maintained while the details of the first part are being worked out. In drawing III is illustrated a fact which comes out time and time again with almost every subject. There appears in the course of perceptual development a certain point where readjustment of the recognition of the parts is so actively under way that if the subject is interrupted before the readjustment is complete, the reproduction shows the greatest confusion. Thus, in drawing III what had been gained in drawing II seems to be wholly lost. Moreover, the general form of the figure which was approximated in the first drawing is here much less correctly reproduced than in either of the preceding figures. Such a poor reproduction as that in drawing III must be recognized as very striking evidence of the complexity of the perceptual process. The explanation of the period of confusion can be made out very clearly in this case by an examination of drawing IV and reference to the subject's introspections. The introspective record is as follows: "There is a succession of straight and curved lines, but their order is very confused in my mind. I think there should be more curves, especially at the end." The essential point is in this reference to the end. From drawing IV it is evident that the subject is trying to straighten out the confusion at the right end. The right end of the figure was vague in drawings I and II. In II the first part of the figure was mastered. In turning to the right end the confusion arises, as shown in drawing III. The subject has not had time in drawing III to master the right end. This is finally accomplished in drawing IV, but the attention is withdrawn from the general form of the figure and from the first part of the drawing in the effort to work out the last part. Drawing III is a very striking example of the difficulty of any single test of mental ability. Without drawings I, II, and IV a very false notion would be gained of the subject's mental condition from III.

Drawing IV shows, as has been pointed out, the mastery of the end of the drawing. It also shows that the subject has mastered a general characteristic of the figure, which consists in the alternation of curved and straight lines. The introspective records show that this principle has been explicitly recognized. That the perceptual record of the first part of the figure is wholly incorrect shows what is certainly a general tendency in adult mental processes, namely, the tendency to generalize perceptual experiences under some abstract statement and to neglect the perceptual details out of which the abstract statement grew. The subject of these tests must have seen the succession of straight lines and curves, but was evidently more attracted by the abstract relational fact of succession than by the concrete forms of the parts of the figure. The concrete relations were recognized only at the end of the figure toward which perceptual attention had been definitely attracted.

Drawing V shows the mastery of the figure. Its relation to the earlier processes of distribution of attention, of mastery of parts, of confusion and recognition of the general principle of alternation is sufficiently obvious from what has been said. This drawing could not be understood at all if it had been preceded merely by drawing IV or by III and IV. The mastery of the first part of the drawing, as shown in drawing II, is an essential part of the preparation for drawing V. Though the elements mastered in drawing II have been for a time neglected in drawing III and IV, they can be more easily recovered than at first. In drawing II there is evidence that if the subject attended to the first part of the figure, he could not at the same time include in a single process of recognition the last part of the figure. Putting the matter in quantitative terms, we may say that the scope of perceptual consciousness, as evidenced in drawing II, is three clear lines and two vague lines. In drawing V the first five lines are recovered with sufficient ease so

that the scope of perceptual consciousness extends over all seven lines. The greater inclusiveness of perceptual consciousness in drawing V gives evidence of a facilitation in some degree of the perception of the first five lines; and since this facilitation did not occur during the period occupied in drawings III and IV, it must have been carried over from the period of drawing II.

The remaining drawings of this series show certain details which are typical. Thus the angle of line three deteriorates instead of improves through the later drawings of the series. This may be connected with the fact that the greatest error in all the later drawings is to be found in the angle of line four. There is very noticeable variation in the position of line four. In drawing VIII it is better than in drawing VII, but in IX it is again worse than in drawing VIII. In drawing X there is a very decided improvement in the position of line four. There is, on the other hand, in drawing X, not merely the deterioration of line three noted above, but also a very marked lapse in the length of line six. Other similar facts will be obvious from the drawings.

The various lapses and slight improvements in the last five drawings show very clearly why there is so little improvement in our ordinary perception of complex figures. Attention is from moment to moment fastened upon this or that detail of the figure and there is a corresponding withdrawal of attention from some other part. The complete mastery of all the details is therefore a long process. In most ordinary experiences the interval between observations is so long that the lapses more than make up for the periods of improvement, and so we have merely crude approximations to complete and correct percepts.

Another general fact shown by the series as a whole is that the size of the figures is throughout too large. Indeed, there was a very general tendency, on the part of all the

subjects to make mistakes in the size of the drawings. The significant fact in this immediate connection is that the subject was in no case conscious of the error in size. That is evidently a matter upon which attention must be especially directed. While attention is on the various lines and their positions, there is little attention for size.

Space Perception a Complex

The foregoing discussion makes it clear that the recognition of form and distance develops in the course of experience. We now turn to the demonstration of a second general fact with regard to space perception. The recognition of distance and form depends upon the bringing together or fusion in consciousness of many sensory elements. Let the reader try the simple experiment of covering and uncovering one eye while observing carefully the distance in depth between the objects before him. He will note how his recognition of distance is affected by the presence of sensations from both eyes in the one case, and by the withdrawal of part of his usual sensations in the other case. When he sees with only one eye, the world seems to flatten out into a single plan; when both eyes are open the objects stand out in clear relief, showing the importance of the two sets of sensations derived from the two eyes for a clear recognition of depth.

Further Examples of Complex Perceptions of Space

Other examples could be cited without end to prove the statement regarding the complexity of the sensory processes on which we depend for our recognition of form. One of these examples which is easy to present on the printed page may be added, in order to reënforce the conclusion reached

by comparing one-eyed vision with two-eyed vision. First look at two equal horizontal lines such as the following, and note how easy it is to recognize their equality.

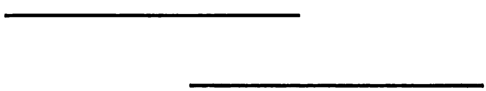


FIG. 2

Then add oblique lines at the ends of the horizontals, and note how the added lines have not merely contributed more experience; they have also changed the apparent length of the horizontals, showing that so simple a mental process as the recognizing of the length of lines can be complicated by added sensations which come from contiguous lines.

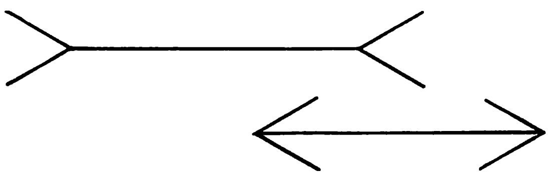


FIG. 3

In general, all lines and forms are seen in their settings, and are influenced by these settings. Or putting the principle in the terms in which it was originally stated, every space percept is a complex made up of many elements.

RELATION OF PERCEPTION TO SENSATION

From the foregoing statement, that space percepts are sensation complexes, we turn to a more difficult and abstract matter. Space may be defined negatively by saying that it is not a kind of sensation. Thus space is not color. One can lay before his eyes variously colored squares which are alike in their distance from the eye and alike in their contours,

but different in their colors. The spatial characteristics of these squares — that is, their forms and distances — are alike, but their colors are different. In like fashion it can be shown that space is not a touch sensation. I can reach out with my hand and touch these squares. If I keep my eyes shut as I reach, the distances and forms which a moment ago were perceived through the eyes will be perceived through the sense of touch without color. The distance will be recognized as the same as the distance seen, and the form as the same as that which was recognized with the eyes, but the sensory elements will be those of touch rather than of vision. Furthermore, distance and form are not only not identical with color sensations, they are quite as emphatically not identical with pressure impressions, with smoothness and hardness, or with coldness and muscular strain. We find thus that space is a type of experience into which vision or touch or other sensory qualities may enter, but space is not one of these sensory qualities.

At times psychology has been disposed to find in sensations of movement the explanation of space perception. The sensations from joints and muscles have been looked upon as the important factors in building up notions of space. This emphasis of sensations of movement does not contradict the statement that space is not identical with these sensations. If movements help to build up space ideas, it still remains true that the space scheme is comprehensive enough to include also sensations from touch, vision, hearing, and other senses.

The foregoing statement can be reënforced by calling attention to the fact that some sensory quality must always be present when we perceive form or distance. These spatial characteristics of things are no substitutes for sensory qualities. Thus, let one try to think of empty space: it will be noted that attention tends to fasten upon the wall around the empty space. Or if one tries to think of the middle of

a vacuum, there will be a vague gray visual content filling the space. All these positive factors can be changed in quality, and yet the space may remain the same. Again try to think of infinite space: one moves on till he reaches in imagination a distant cloud, and after pausing a moment he moves on again through the vaguely seen gray distance. The man born blind, who has never seen clouds, represents infinite space in his imagination as the experience of swimming on and on without stopping. All these examples show that space is not identical with sensation; yet, on the other hand, it is never experienced except when sensations are present to fill it or surround it.

Space a Relational Form of Consciousness

The statement for which we are now prepared is that space is a species of relational consciousness; it is a mode of arranging sensations. Thus, when one notes the distance between two points he has a conscious experience of transition from one point to the other. During this transition he may see a white or black surface, or he may feel his arm moving, or he may recognize that his finger is passing over a rough or smooth surface. The sensations of color or touch which fill one's consciousness are stepping stones for one's spatial consciousness. The space perception itself is the stride from one sensory element to the next. Space is a relational fact, not a new sensation. As a relational form of consciousness space has certain characteristics which are like those exhibited in the higher forms of experience. Consciousness of transition is a general term which may apply to a great many different kinds of experience. Thus, I think not only of transition from near to far; I think of transition from a sad feeling to one of rejoicing. Wherever my experiences show gradations and I can note the transition from one gradation to the other, I have a form of

consciousness which is similar to space in the fact that it is relational.

Space is the most fundamental, direct, and familiar form of relational consciousness. The only other relational consciousness which is anything like as familiar as space is time. We shall not complicate the present discussion by attempting to describe the nature of time-consciousness. It is enough for our present purpose to note that space and time are the two universal forms in which all sensory facts appear in experience.

Some reader may be wondering why the discussion of space is carried on in terms of consciousness. Why not talk about space as the receptacle in which all the things in the world are contained? Why not treat space as an external reality of a superior order embracing all the objects in the world? The answer to these questions is that the consideration of space as an external receptacle leaves us absolutely in the dark as to how it is known by human beings. We have a sense which explains our experiences of light and color. We have another sense for sounds, and another for touch qualities, and so on, through the whole list of qualitative experiences, but we have no sense through which we can get knowledge of a receptacle in which objects are contained. Empty space has no positive characteristics which it can impress on the mind. One could admit the existence of an external receptacle in which things are contained, and he would still have before him the problem. How is this receptacle known? How does it get into the mind?

In attempting to answer the question how space gets into the mind, psychology has been led to the statements made in earlier paragraphs. Space is recognized through the building up of a series of relations in consciousness. We pass from one object to another, the intervening sensations get themselves organized into a system or series of

related experiences, and then we speak of space as the relational aspect of the whole. We can talk about space as though it were empty. As a matter of real experience space is recognized as the transition from one object to another. It is the form or order in which objects are arranged. Empty space is not a really recognized fact; it is what remains if we think of all sensations as dropped out of our real percepts.

THE GENESIS OF SPACE IDEAS

These statements will become clearer if we study briefly the development of the child's recognition of space. If one touches an infant of six months of age on the back of the head, the infant will get a sensation. He will respond by trying to put his hand on the stimulated spot, but he does not know where the sensation is, and shows that he does not know by his irregular and ill-directed movements. The infant has no spatial scheme in which he relates this sensation to other sensations. As his experience matures he learns that this particular sensation has a definite relation to many other sensations from other points on his body. He learns that each sensation calls for a particular movement of his hand, and he thus learns where the back of the head is. He has learned to recognize the relation of sensations from the back of his head to the rest of his world.

Another example of learning to locate objects can be drawn from the experience of the tennis player. He gets a series of visual impressions as the ball comes toward him. These he meets with a complex reaction of his arm and hand or of his whole body. When he strikes the ball, he has successfully worked out a most complex adjustment of all the factors of vision and touch, using these to guide his motor organs. If he does not meet the ball, he exhibits the difficulty of relating the various factors of experience to

each other, and the difficulty of moving his hands properly when experience is imperfectly organized.

The foregoing examples show the importance of bodily movements in the development of space percepts. The infant learns the parts of his body by moving his hand to them; the tennis player learns to locate ball and hand by trying to move properly. So significant is movement for space recognition that some psychologists, as mentioned above, have held the view that space is a series of movement sensations coming from the joints and muscles. It is not necessary to enter into further critical discussion of this doctrine here; enough to remark once more that the importance of movement sensations can be fully recognized, and there yet remains the problem of explaining how all other sensations — colors, touch qualities, sounds, and the rest — come to be included in a single space scheme. Space, whatever the value of muscle sensations, is always something more than these sensations — it is a general form of consciousness in which muscle sensations, visual sensations, and all other sensations are arranged.

Space and Movement

Indeed, we may go a step farther than do the muscle-sensation psychologists, in emphasizing the importance of movement for the development of space perception. Movement is more than a mere source of sensations; it is a constant check on all our efforts to arrange our sensations in the space form. If one sees a book on the table and, estimating its distance, reaches for it, he will, by the act of reaching, instantly prove his visual recognition of distance to be right or wrong. We are thus constantly improving our visual evaluation of the space relations within which we move. Things within our reach get properly related to each other and to our bodies, because if they did

not we should fail in our practical adjustments. The world immediately under our hands gets organized in this practical way with a high degree of completeness. This appears in the fact that we recognize the spatial relations of the things near at hand more fully than we recognize the spatial relations of things remote.

Furthermore, space, as we know it through the practical organization of responses to sensations, reflects all the mechanical laws of weight and movement, because as we learn to relate our experiences in space we are constantly

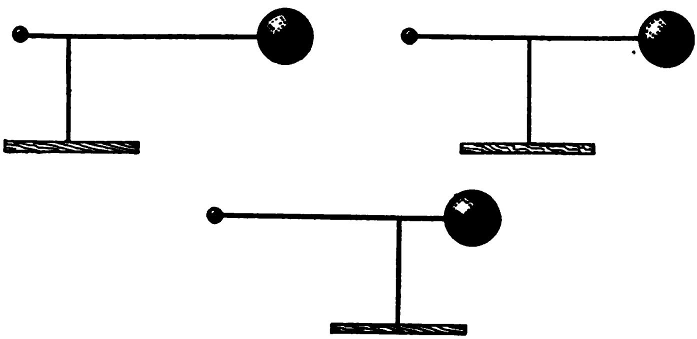


FIG. 4

under the guidance of mechanical laws. For example, let the observer decide which of the three figures given above (Fig. 4) he prefers. He will inevitably choose the third, because the two black spots do not balance mechanically in the first two figures. The recognition of the lack of balance is in one sense not a matter of space perception; in another and important sense it is quite impossible for one to see the spatial relation between the two black spots without evaluating this relation in terms both of spatial distance and mechanical balance.

Space perception is thus seen to include the results of many of our practical adjustments to objects about us.

Conversely, when we have no practical motives for detailed adjustments to objects and sensations, we are likely to be deficient in space perception. Thus, as mentioned above, the ordinary man sees people when looked at from a high building as small. Most of us have never had occasion to perfect our space perception of objects far below us.

Another significant fact is that certain of our spatial percepts remain imperfect because the kind of practical adjustments into which these percepts enter do not require that we pay close attention to spatial details. Thus I see the face of my friend and recognize only so much of the spatial details of his features as I need to keep him distinct from other people. I do not explore his features as I should have to if I wanted to draw his face. My experience has developed only so far as my practical efforts have required.

The example becomes still more striking if we consider the lack of space perception which one exhibits in the presence of persons whom he passes on the street and neglects because their faces are not familiar. One scarcely sees the details of these faces at all.

From such examples as these we see that the degree of spatial analysis depends directly upon the kind of use which one is going to make of his sensations. The artist makes one kind of analysis of a mass of sensations, the familiar friend makes another, the stranger a third.

Universal Characteristics of Space Percepts

Whatever the individual differences in our perceptions of space relations, there are certain respects in which we all agree. Thus all human beings look at the world from an upright position. As a result we all recognize a vertical line as having unique value as a line of reference. Whatever departs from the vertical is recognized with vividness. On the other hand, a few degrees of deviation from an

angle of forty-five degrees or from an angle of sixty degrees are recognized very imperfectly. The vertical line is a fact of major importance in the experience of all human beings. In like fashion the experiences described by the words "up" and "down" have a distinct and common value for all human beings. The same is true of the words "backward" and "forward."

Jennings has given a striking illustration of the fact that one human being is more like another human being in matters of space experience than like some of the lower animals. Take, for example, the starfish. For this animal there is no forward and backward. His radial structure makes every direction a forward direction. If one wishes to put the starfish in a position where its experiences and movements will be analogous to ours, one may turn it over; then the distinction between right side up and bottom side up appears as a fundamental distinction in the experience and behavior of the starfish, but for the starfish there is no forward and backward.

The universal characteristics of space perception arising from our common human structures give us all a sufficiently definite basis for understanding the spatial experiences of others, so that we overlook our individual differences and think of space as alike for all human beings. Indeed, in ordinary intercourse we think of space as quite as real and independent of individual perception as is light or sound vibration. To be sure, when a layman compares his perception of space with that of the artist, the layman realizes that he is deficient in a sphere where the artist is expert; but even with this difference in mind the layman knows that in fundamental characteristics his perception of space is like that of the artist. In other words, human nature being what it is, all men are fundamentally alike in the essentials of space relations.

It is an interesting speculation to consider what must be the form of experience of space of a bird or of a flying

squirrel. The ordinary standards of comparison with our fixed vertical must be replaced by wholly different standards.

Again we can gain a more vivid conception of the character of our own space world by imagining such contrasts as are presented to us by the non-Euclidean geometricians. Our space is three-dimensional. Imagine a race of intelligent shadows confined in their movements to a world limited to the surface of a table. To such beings many of our movements through the third dimension would be absolutely unintelligible. If, for example, a shadow living on the surface of a table could observe the fact that I take a book from the table and bring it down on the other side of him, he would be at a loss to know how the book could disappear from his world and then reënter it at a new point.

These contrasts with human space perception give some insight into the importance of the statement that all human beings are fundamentally alike in their space perceptions.

Psychological Grounds of the Formal Character of Geometry

Another fact regarding space which is of great moment to the student of geometry depends on the general principle that space is not a particular kind of sensation, but a general scheme within which all sensations can be arranged. We can accordingly study space relations with the aid of any available objects. Thus, if one wishes to study the effect of rotating one object around another, he does not have to secure any particular objects. He can use outline figures on the blackboard, or the books which lie on his table, or carefully constructed geometrical models. Space is thus a very simple kind of experience to demonstrate. The man who is blind can understand space relations just as completely as the man who sees. Even the fact that the blind man is limited in the range of his space perceptions does

not prevent him from deriving from his limited world all of the broader notions of space. Space is a relational aspect of experience and appears in the same fundamental forms, whatever the sensory contents which are brought into the relation.

In fact, space is so easy to express and demonstrate that it becomes in mental life the standard experience in terms of which we describe many other relational experiences. Thus, when we wish to make a statement about our feelings, although they are absolutely unspatial, we speak of them as elevating or depressing. When we talk about values we describe them as high or low. We speak of all men in a democracy as on the same level. These expressions show how dominant in human life is this vivid, relational experience of space.

Not merely in crude popular thought is space the typical and most readily demonstrated relational experience; in the most exact science, space is used as the convenient medium of expressing all relations. If the physicist wishes to describe the weights which can be carried by steel or concrete of different grades, he assembles all his facts into a graph. The graph shows the whole series of varying relations. The economist shows by using a graph how stocks and bonds fluctuate from day to day and from week to week. These uses of space as a means of expressing non-spatial facts show, first, that space is a relational fact, for otherwise it could not express all the other relational facts which are put into graphs; second, that space is the most directly perceived and familiar relational fact in human experience. They explain also the unique importance of the science of space as the science dealing with the most familiar and readily demonstrated relational fact in conscious experience. They also explain the fact that geometry is so often mistaken for logic.

HIGHER FORMS OF REASONING APPLIED TO SPACE

Before we turn to the study of geometry we must carry our psychological analysis one step further. Geometry employs certain forms of comparison which are of a higher mental order than space perception itself. Thus I can say of two squares that they are alike in form. The recognition of likeness is of a higher type than the mere recognition of the square as a spatial form. I can say of a triangle that it has three sides. Here I have exercised a power of analysis on my spatial experience and have compared this three-sided figure with other figures of more or less numerous sides. Enumeration of parts, with its attending analysis, is a process of comparison differing from mere recognition of form.

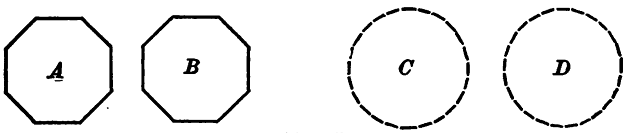


FIG. 5

The foregoing remark can be amplified by examples of comparison at various levels of difficulty. Thus, if I recognize that the two figures *A* and *B* (Fig. 5) are alike in form, I make a very direct comparison which is hardly more elaborate than the direct recognition of the figures compared. But if I try to compare figures *C* and *D* and ask whether they are alike in form, I find that I am in difficulty, because the figures are complex; and exact comparison requires a minute discrimination which in turn requires a very detailed recognition of the figure, possibly even a counting of the sides. Comparison in the latter case will require methods which were not necessary in dealing with *A* and *B*.

These cases show us that direct perception of form and higher comparisons or scientific study of forms belong to different levels of mental life. To see a triangle is one

experience; to discover its properties by analysis and comparison with other figures is another level of thought, involving forms of relational consciousness higher than space perception. Undoubtedly one's perceptions of figures will be influenced by his scientific study; that is, one who has studied a pentagon will recognize it more readily and more fully than the observer who has not studied it; but study and recognition, though mutually interdependent, are different in character.

That study and direct recognition are not the same appears from the fact that two persons may gain intimate knowledge of the same form by two wholly different routes. Thus the practical carpenter who repeatedly cuts out a certain form in wood will come to know this shape intimately. When he sees the familiar form in other settings he may recognize it at once. In like degree the geometrician may cultivate intimate knowledge of the same form and may recognize this form wherever it turns up. The two men may both see the form with something like the same detail and accuracy. They will, however, differ absolutely in the types of experience which attach to their percepts. To one the recognition of the shape suggests the tool which cuts out the figure; to the other the shape suggests ideas of angles to be measured and lines to be projected into infinity. The percepts in the two cases have entirely different connections and relations, though the accuracy with which they are recognized is the same.

Space Perception and Science of Space

We may think of one's space percepts, therefore, as a result of those mental processes which from earliest childhood have contributed to one's recognition of form and distance; or we may think of space percepts of lines and figures as the raw material to be taken up by higher forms

of comparison into the sphere of a scientific study of spatial characteristics. Considered as a product of contact with things, space perception is an organized arrangement of sensory qualities in a series; considered as material for scientific study, space is a group of facts to be analyzed and compared with a view to defining more fully the remote and less obvious characteristics of particular figures. This contrast may be made clear by pointing out one of the problems encountered by the teacher of solid geometry. Many a student has difficulty with solid geometry because he does not know what the flat figure on the page means. His teacher expects him to have in mind a solid object filling three-dimensional space. He cannot supply the three-dimensional idea. It is therefore impossible for him to go on intelligently with the study of the solid object. He does not have the space idea needed to furnish the raw material for scientific studies. Writers on the teaching of geometry have urged that it is a mistake to give models and photographs to students when they are studying solid geometry. The writer saw this pedagogical doctrine carried one step further by a teacher who did not draw even the flat figures of plane geometry on the board, but required the members of the class to keep the figure in mind after it had been drawn by a movement of the hand in the air before them. This teacher's contention was that reasoning about figures was more exact if the students had the figure in their heads.

Teaching of Geometry involves a Variety of Processes

Whether we accept the verdict of those who object to concrete forms as aids in the study of geometry or not, one fact is certainly clear: there are two problems involved in a geometrical demonstration — first, there is the problem of making sure that the student has clearly in mind the figure

which is being discussed; second, there is the problem of studying the figure. If the student does not know the figure, or if he cannot hold it in mind, he cannot perform the later, more complex mental operations of dealing with the figure. If one has the figure in mind, then the real business of the science of geometry can begin. The science of geometry undertakes an analysis and comparison of figures, and involves higher forms of consciousness than those which are cultivated in the perception of forms and distances; but it requires a high degree of space perception before the student can take up scientific analysis and comparison.

The conclusions reached in this chapter prepare the way for a psychological study of geometry and of the relations both of space perception and geometrical analyses to other types of thought, especially those which appear in the sciences of arithmetic and algebra. By way of summary it should be borne in mind that the recognition of space is a complex psychological process which develops in the course of individual contact with the world, especially through movements in the world. Space is not a form of sensation and is not dependent on any single group of sensations. It is a relational type of consciousness. As the most vivid type of relational experience, and as one which can be reproduced through our own rearrangements of any convenient objects, it serves as the pattern for the expression of all other relational forms of experience. Space is in turn capable of analysis and comparison; and through these higher forms of study, space perception is itself refined and clarified and is made the object of an elaborate science.

CHAPTER IV

THE PSYCHOLOGICAL ANALYSIS OF GEOMETRY

SOURCES OF MATERIAL

In attempting to make a psychological analysis of geometry there are several possible sources of material: first, we may take a textbook prepared for the use of students, and note the mental processes which the successive exercises are intended to call out; second, we may attend class exercises in the subject, and give attention to the mental processes of the students, noting incidentally the mental processes of the teacher and his ability to recognize what is going on in the minds of his students; third, we may go through the various books which have been written on the teaching of geometry, noting the problems which are there discussed and the solutions offered by the various writers.

TEXTBOOK METHOD OF EXEMPLIFYING SPACE

The textbook in geometry which we shall use for the purpose of this study[1] begins with a series of definitions of the terms which are to be employed. On the first page is the figure of a cube. The figure is a less complete basis for direct perception than a real cube would be, because it is two-dimensional; but with all of its limitations it furnishes a concrete perceptual basis for the study. We pause to note that space is one of the simplest materials to present to students. Most sciences have to collect their materials at

[1] G. A. Wentworth, Elements of Plane and Solid Geometry (edition of 1889). Ginn and Company.

some cost of time and energy, but space is everywhere available. The figure of a cube allows the author to begin with a definite concrete example of that which his science is to study. By looking at the figure given in the book and by reading the text, the student is led to recognize the fact that the cube has a number of different surfaces, lines, and points. The psychological process which is here involved is a process of analysis; the parts are distinguished. As soon as the student distinguishes the parts of the figure, the definitions draw his attention to the fact that the different parts of this figure have different characteristics as well as different appearances. Thus a side or surface is different from an edge or line.

Value of Verbal Discussions

The words used in the definition have a double value: first, they direct the attention of the student so that he selects certain aspects of his percept for attentive consideration; second, the text helps the student to substitute words for his percepts. The use of words instead of figures makes it possible to carry on later discussions in a way which would not have been possible if space images alone were employed. Words are more readily compared, and space ideas which have been turned into words are by this translation made ready for new and higher nonspatial comparisons. Thus the word "line" may be put into all kinds of sentence relations; it is a more plastic element of experience than is a linear figure.

In a later chapter we shall have opportunity to comment more fully on the flexibility of verbal ideas and upon the fact that the human mind tends to carry on all its higher processes in verbal form. At the moment we must be satisfied to note that the association of space ideas with words raises the mental processes of the student to a level where

scientific comparisons are rendered easier. This fact is illustrated by the use to which the verbal ideas are put, even in the preliminary definitions. Thus we come very soon to the statement that a line has only one dimension, namely, length. Here the student is called upon not only to relate a visual image of a line to a word, but he is called upon to strip the visual image of certain of its obvious characteristics. He knows that every real line which he sees has breadth and thickness; but he must learn that it is not the purpose of the student of geometry to give attention at any time to the breadth and thickness of the particular lines with which he has to deal. Words, therefore, help the student to carry his analysis beyond the figure as it is presented to his senses. This ability to go beyond the real experiences in the interests of a special scientific study we call abstraction. The use of words in geometry, therefore, is an example of one of those higher forms of thought which were discussed in the last chapter, when it was pointed out that space is not only recognized, but is also compared with other experiences for the purpose of bringing out characteristics which can be apprehended only through higher forms of thought.

Special Scientific Symbols

The first page of definitions furthermore exhibits a device whereby the student's attention may be fixed upon certain parts of a figure through the use of symbols, which are even simpler than words. One corner of the cube is designated by the letter A, another by the letter B, and so on. We have here a technical kind of terminology which is created for the purposes of geometrical study. The terminology is relatively simple from one point of view. It avoids such circumlocutions as this: "that surface of a cube which is turned directly toward the observer," or "the

corner of the cube which appears at the lower right-hand side of the page." Rather than use these long and clumsy descriptive phrases, the author uses a single letter or series of letters. By putting letters on the figure, and using them in the later discussions, he gives a perfectly clear designation to the parts of the figure with which he wishes to deal. Such letters are, however, dependent for their interpretation on the figures to which they are attached. Unless one has the figure before him or in mind, he will not be able to use the letters. The word "line" or the word "surface" each has a meaning which is independent of any particular figure or any particular connection in which it may be employed. It is therefore a general term, or a meaningful term, for all connections; but the letter *A* is a specific term relating to a specific figure, useful as a technical abbreviation, but not significant when taken out of the particular connection in which it is given. Every teacher of geometry knows the disastrous consequences which follow when a student fails to keep together in thought the letter and the figure to which it properly relates. Words are in a measure open to a like objection — that the student sometimes goes astray because word and meaning get separated; but a letter, for the reasons given, is much more in danger of losing its connection.

Abstract Ideas

Especial attention should, perhaps, be devoted to the type of idea which the student is called upon to develop in connection with the definition of a point as a purely geometrical conception. "A point," he is told, "has no dimensions, but denotes position simply." This definition of a point is an effort, as is the definition of a line, to aid the student in getting rid of the direct sensory content which is always present in any real point which he observes. The definition

illustrates very fully the conclusion which was reached in the last chapter, when it was pointed out that space can never be recognized except in terms of some kind of sensory content. One tries by the substitution of an abstract verbal idea for sensory content to get rid of as much sensory content as he can, in order to leave behind the pure spatial elements of experience.

Another definition which may be noted as especially significant for our psychological study is that in which the student is told that any figure is a limited portion of space. This definition calls attention to the fact that the same kind of space extends on all sides of a given figure. There is an implication here which comes out more clearly in later discussions; namely, the implication that any limited portion of space has the fundamental characteristics of all space. Indeed, geometry recognizes that all space is absolutely homogeneous. Any limited portion of space which is selected for discussion is a representative of other limited portions of space or of space in general. We may regard a figure, therefore, as a representative example rather than as a single isolated experience significant in itself. Thus, while our definition of a point attempts to get rid of all the content, the statement that a given figure is a limited portion of space attempts to generalize or extend the conclusions of any particular discussion to the larger field of all space.

Analytical Studies of Space

The mental processes required to understand the definitions which have been discussed up to this point are space perception and the higher processes of analysis, abstraction, and interpretation of symbols.

We pass now to another phase of geometrical science. Not only are the different parts and aspects of figures to

be distinguished, but the properties of figures and geometrical elements must be discovered. What can be said about a point differs from the definition of the point itself, in that higher and more complex groups of ideas are involved. Thus one of the statements which is made about the properties of a point is that "through a point an indefinite number of straight lines may be drawn." This statement, though included among definitions, is not strictly a definition. It is, rather, an effort to get the student to consider carefully some of the facts which are outside of the point, but closely related to it. The statement is put at the beginning of the science because it is obvious. The student can find the truth of this fact if he scrutinizes his experiences, and brings to clear consciousness that which he can readily justify, but which he has probably never before recognized with explicit clearness. The words of this statement are intended to call up in the student's mind a whole series of experiments. He will try to draw different lines through an imaginary point, and will note the characteristic relation between these different lines and the point. The mental process thus induced is relatively direct, but it is by no means a mere matter of space perception. It is a matter of experimentation and a matter of comparison, with a view to discovering and recording explicitly facts which will be of use in later elaborate studies.

By guiding students through such simple experiments as these the geometrician prepares them to try all possible combinations and recombinations of figures. One can imagine, for example, that the first student of geometry who explicitly formulated the statement that an indefinite number of lines can be drawn through a single point regarded the fact as a discovery. It was a discovery, not of an obscure fact, but a discovery in explicit form of a fundamental fact which all along had been present in experiences, but was now brought to attention as of sufficient

importance to be treated as a distinct and explicit matter of comment.

There is a large part of geometry which may be described as the explicit statement of characteristics which are capable of direct observation, but which are not distinguished from total experience until geometrical analysis has made them clear. The attitude of an ordinary man to one of these explicit statements in geometry very frequently is that the statement is hardly worth making because it is so obvious. The attitude of beginning students is very often one of disregard for these obvious analyses, but it is through the combination and recombination of these direct analyses that the science of geometry is ultimately developed. All of the later propositions in geometry must be traced back to postulates; that is, to simple analyses which depend on direct experimentation.

Problem of Pedagogical Arrangement

It might be questioned whether the textbook in geometry ought to give these analyses at the beginning. Certainly the recognition on the part of the student of the motive for these simple forms of analysis is not complete until after he has gone farther in his study. On the other hand, no student will begin to analyze his experiences until someone sets him thinking about the properties of figures. When the child begins to play with paper and pencil and finds that he can draw a great variety of lines, he is working toward the statement that an infinite number of lines can be drawn through a single point, but he is not likely to hit upon that particular idea until he has cultivated a large experience with lines and with points. On the other hand, the scientist who has made a careful examination of the properties of different geometrical elements comes to realize the fact that this statement with regard to lines and points

is the logical foundation for many of the more elaborate discussions and analyses of space. The writer of a textbook, therefore, puts this logically simple proposition at the beginning of his science.

To begin with definitions in any subject requires of the immature student some appreciation of values which it is quite impossible for him fully to recognize until he has progressed to a high degree of knowledge of the subject as a whole. Psychologically, therefore, the procedure of the geometrician in beginning with definitions cannot be justified by the expectation that the matters dealt with in these definitions will be mastered at once by the student. As we shall see later, the early theorems and demonstrations are in reality mere repetitions and elaborations of the definitions. The geometrician undoubtedly holds that the student's time would be greatly economized if he could only take up the subject in the order which the mature science recognizes as most advantageous for the development of the later, more elaborate, propositions. Perhaps it is worth the effort to get as many of these obvious analyses as possible made, even if it becomes necessary to reëstablish the definitions by later reiterations in more detailed form. The student may gain something by the preliminary statement, even though he does not gain all that he might; but the teacher of experience knows how little some students really absorb the first time they encounter these simple analyses.

The practical school problem here presented is one which cannot be solved by adopting any single method of procedure. In some cases a statement of the definition will induce the student to perform the desired mental process; in other cases, elaborate reasoning may have to be resorted to before the student is made to see the truth and its importance. Possibly one order of procedure could be advantageously used by one teacher, while the other order would be more successfully used by a second teacher. This

comment indicates the relation between psychological analysis and the methods of teaching. Psychological analysis does not determine what method is best; it simply indicates the type of mental process which is to be cultivated. There is, therefore, an ample field for experimental treatment of school problems that lies beyond the field of psychological analysis itself. Methods aim to produce psychological results, but there may be several methods of producing a given result. The contribution which psychology can make to methods may be described by saying that the teacher is more likely to understand what he is doing if he considers the type of mental process which he is setting up.

Methods of developing Ideas

It is psychologically interesting to follow the mental development at which the author aims in his section defining angles. Angles are first defined as "the opening between two straight lines." Gradually this definition is amplified until finally we are told that an angle is the result of the rotation of a line about a point. The difference between these two statements is that in the first statement a single definite specimen is chosen as the basis of consideration. When we take a single angle and consider it as a fixed quantity, we may illustrate it and discuss it quite apart from any other elements of space. When, on the other hand, we generate an angle by rotating a line about a point, we show the relationship between any given angle and the rest of space. The angle comes to be a part of a general spatial scheme. The relation between all angles is suggested at the same time the properties of a single angle are exhibited. The term "angle" thus comes to have a very much broader connotation than it does in the first definition. Or one may say that a principle of construction is substituted for the figure.

Methods of Training in Comparison

The chapter on definitions next explains certain simple forms of comparison which are not spatial at all but are relational in one of the higher senses referred to in the discussions a few pages back. Thus the student is introduced to methods of superposition. When two lines are superimposed upon each other or two angles are superimposed on each other, they are compared with a view to discovering their likenesses and differences. The discovery of likenesses among lines is comparable to the discovery of likenesses in economic values or the discovery of likenesses in rhetorical forms. When we say that likeness or equality is a general characteristic discoverable in many different mental experiences, we must amplify this statement so as to bring out the fact that the method of reaching the judgment of likeness is different in different cases according to the material compared. If one compares economic values, for example, he does not superpose one value upon another. If one compares two musical notes, he cannot superimpose them to discover whether they have the same pitch. These examples show that the comparison of two lines is a special problem which requires the student to know not only how to recognize the one line and the second line but also how to make the comparison in a definite and well-ordered fashion. The geometrician finds it necessary to direct his student, therefore, in methods of making comparisons. Comparisons are necessary in order to bring out the remoter characteristics of figures. The single figure is no longer the subject of recognition and discussion; the single figure must be understood by finding its proper place in science, where likeness and unlikeness are quite as significant as distance and form. Indeed, for purposes of further mental development and for purposes of application, comparisons are indispensable.

Geometry goes far beyond Space Perception

It is thus made clear that it is a mistake to assume that geometry is the art of seeing space. Geometry is rather the science of finding out all that can be discovered with regard to the characteristics of spatial figures. The scientific investigation of the characteristics of figures leads us into the most elaborate logical processes of comparison and inference. Indeed, so large a part of geometry is made up of comparisons that the mere recognition of figures is likely to drop in the background. We select a few easily accessible samples of angles and compare these with each other. We select a few examples of triangles and compare these with each other. The student learns how to make the comparisons in these relatively simple cases. He then generalizes his findings in the form of a principle, which principle is not a matter of perception at all.

We may digress for a moment from our study of the textbook to call attention to the fact that the science of geometry may contribute little or nothing to the student's perception of space. Space, as it confronts the student in architectural forms, in the shapes of animals and trees, in the perspective of the street, and in the shadows of solid objects, may be entirely overlooked while the student buries himself in the pages of definitions and comparisons which go to make up his book on the science of geometry. To be sure, the analytical studies of figures might make the student more intelligent in the observation of form if he would apply his analysis to objects about him. It has been one of the mistakes of the modern school that it has assumed that the student can readily carry over his textbook studies into ordinary life. What is needed is more attention to the observation and analysis of all forms. The student must be taught geometrical analysis, and, at the same time, he must be taught to apply this analysis to figures outside of the

textbook. In later chapters we shall have occasion to come back to this problem of generalizing experience. For the moment we must be content to leave the matter, with a reiteration of the statement that geometrical analysis and space perception are different processes, and that there is a possibility of their developing in the student's mind quite apart from each other. The student must, however, in any case, have enough space perception to furnish the basis for his complete scientific study.

Geometry and Mechanics

Returning to our examination of the textbook, we find after superposition a discussion of symmetry. The type of comparison here involved is higher than that required to discover equality. In superposition one thinks of a spatial element brought into the closest possible relation to a second spatial element with which comparison is to be made. In the case of symmetry the two spatial facts to be compared lie on opposite sides of the center of comparison. The mind must therefore pass from one side of the symmetrical figure to the other in making its comparisons. Furthermore, the elements must be compared with due regard to the fact that in their present relationship they resist superposition.

As pointed out in the last chapter, all of our space ideas are developed in a world where movements must follow mechanical laws. Consequently, all our space experiences contain a large element of conformity to mechanical laws. Symmetry of spatial figures is an aspect of space perception which differs radically from that aspect which we refer to by such terms as "length" and "distance." Length and distance depend upon quantity of experiences, but symmetry depends rather upon a recognition of mechanical balance. When we deal with symmetry, therefore, we are dealing

with a special aspect of space experience. Geometry has never been satisfied to regard comparison through symmetry as of equal fundamental reliability with comparison through superposition. When, for example, one wishes to deal with the vertical angles which are made by two intersecting lines, or with the relations of the angles formed by a line crossing a pair of parallels, he finds himself trying to reduce an experience which is primarily an experience of symmetry to that type of comparison which we have in superposition. The geometrician frankly acknowledges that this effort to reduce symmetry to superposition is artificial and probably unnecessary, but he does not feel satisfied to rest his geometrical demonstrations upon the recognition of symmetry, because such recognition seems to be more indirect.

Thus we see that a psychological analysis of the notion of symmetry throws an interesting light on an ancient geometrical discussion. Symmetry is not as direct as superposition. Superposition in turn is not as direct as simple perception. Possibilities of error increase with the increasing complexity of the psychological processes. Stating the successive stages of probable error explicitly, we may say that the perception of a line is simpler than the comparison of one line with another. The comparison of one line with another when they are placed side by side is easier than the comparison of two lines which balance each other on two sides of a point. Geometry gives us a definition of a line which is looked upon as unquestionable. Geometry makes certain fundamental and very direct comparisons of lines by superposition. In practical experiences these superpositions become more and more uncertain as the objects superimposed become more complex. All the difficulties which arise in measuring can be cited as examples of increasing difficulty of comparison, for in processes of measurement we have to deal with complex superpositions. Finally, geometry becomes very cautious when comparisons

begin to depend on a recognition or demonstration of symmetry. Here it is insisted that the problem be broken up into elements and the comparisons reduced, if possible, to one of the simpler forms.

Working Definitions included in Geometry

We may pass over briefly the paragraph of definitions dealing with such terms as "proof," "theorem," and "problem." These definitions of terms are not directly concerned with space, but are intended to indicate to the student the various different modes of procedure which are followed in performing geometrical analyses and comparisons. For example, when the definition of a construction is given, the definition is merely the statement that in certain cases certain preliminary steps must be taken by the student in order that he get a clear notion of what he is going to do. Geometry has to employ such terms describing procedure in order to set the student at work on the problems which are to be solved. Such terms as these are not, as stated above, spatial; some of them are not even logical terms; they are working terms used in collecting the material for geometrical comparisons.

Logical Definitions

We come finally to a discussion of axioms and postulates. The postulates are to be distinguished from the axioms by the fact that postulates describe spatial experiences, whereas the axioms refer rather to the fundamental laws of thinking which are valid for all sorts of processes of comparison. Thus the first postulate states that a straight line can be drawn from any point to any other point. Contrast this with the first axiom, which states that things which are equal to the same thing are equal to each other. The

postulate deals with a spatial fact. The axiom, on the other hand, is not a statement of a spatial fact at all; it is rather a fundamental principle of a logical type. It is important to note while making this distinction that the logical axioms of geometry are always looked upon by geometricians as parts of their science. This fact gives increasing evidence in support of the conclusion pointed out before, that the science of geometry is so absorbed in directing and controlling processes of comparison that in many instances the spatial material on which these logical processes are exercised sinks into the background. Geometricians often neglect space and emphasize logic. The result is that in many cases the student is trained not in the observation of lines and figures, but chiefly in the methods of making logical comparisons. It is possible to find students of geometry quite unobserving of form. This situation will be understood wherever it is found that the primary emphasis is on axioms.

Theorems contrasted with Definitions

We turn now to the first book and find that the early theorems are elaborations of the definitions given in the preliminary pages. These early demonstrations are so direct and obvious that the psychological analyst is at first in doubt as to the possibility of discovering any new mental processes not found in the foregoing study of definitions. However, on closer study a clear psychological and pedagogical difference appears between definitions and demonstrations. A definition is a closed, compact statement. A demonstration is a detailed and explicit unraveling of the situation. In a demonstration, however simple, one phase after another of the total situation is scrutinized and reduced to the form of a separate statement. While the early theorems do not use very complex series of statements, they train

the student in the use of a form of analysis which was assumed but not demanded in the definitions. If the student can be trained in analyzing a situation which is fairly obvious, he will be better prepared to take up situations which are not obvious. Furthermore, this explicit analysis serves to review many of the statements included in the introductory chapter on definitions.

Finally, one notes as he examines the demonstrations that they are made up of successive steps, which steps must be held together in one general mental process. This process of holding together the products of analysis calls for a type and reach of attention which is higher than that which is required in learning a definition. To hold in mind a single question, and bring to bear in answering this question a chain of evidence, is a higher type of reasoning than that which is involved in mastering a single final statement.

The later demonstrations which appear as one progresses through the text involve in increasing degree this power of combining the results of successive steps of analysis. They also involve retention and recall of the results of earlier discussions. It would be interesting to find out in what terms different students remember propositions. Doubtless there are some students who recall vividly the spatial figures; others recall the verbal formulas used in stating the theorems; others think of the steps of reasoning. The ability of a given student to use his knowledge of a theorem in later demonstrations is undoubtedly related very closely to the form in which propositions studied earlier lie in his mind.

Psychological Analysis of Original Problems

The last remark leads us to a consideration of the difference between a demonstration and a so-called original exercise. In the original exercise the student must first analyze the situation which is propounded, and then he

must be able to draw out of the fund of experience which he has accumulated the principles which will help him in solving his complex present experience. There is no rule which can be learned to guide in solving originals, because the solution depends on the student's ability to look around in his mind and find among the contents of his experience the propositions which fit the present case. The psychological process can be described after it has taken place; but it cannot be prophesied in advance, because the student may make his analysis in one of many different ways, and he may make many a failure in trying to fit one remembered proposition after another into the present situation before he finds the right combination to complete the thought process. The only way to teach a student to solve originals is to teach him how to analyze a new problem and how to seek among his store of experiences. A demonstration given in the text, on the other hand, requires only ability to follow the statements that are set down in the book. The student does not have to search around in his mind among the many possible combinations; he has only to follow one combination which is given. The student gets inferior training when he merely follows another's lead. If he stops to think at all how the author hit on the solution of his problem, he is apt lazily to set aside the question because it seems unnecessary.

The student should in some way gain an insight into the methods employed by the author in solving his problem. Whenever it is possible more than one solution of the problem should be presented, and the merits and demerits of each solution should be discussed. Some comments on method should be introduced into the text itself. The only possible justification for giving a student a solution is to train him in methods of solving problems economically and in rigid form. The mistake is too often made of dragging a student along too rapidly over a path which someone else has

mysteriously marked out. The student walks in the path, but never for a moment thinks of stepping out of it or moving faster than his guide. Geometry learned under such conditions becomes the most formal kind of drill in memory. Students thus trained never can apply what they learn. Indeed, they are more and more bound down by every lesson they study to a slavish adherence to the text. Rote memory is thus unfortunately substituted for the supposed scientific analysis of space, which is the aim set by the teacher of geometry for his work.

Psychological Material derived from Observation of Class Work

Turning now from the textbook to the students, we must note one general fact; the reactions of students to the lessons set for them are infinite in their variety. No psychological principle is more strikingly proved by every class exercise than the principle that mental life shows marked individual variations. The effort to give an outline of some of these individual variations may seem to experienced teachers labored and meager in results, but it will be undertaken in the hope of stimulating these experienced teachers to record their broader observations. For the purposes of this study the writer visited a class of second-year students who had been studying geometry for seven months. The class exercise preceding the one visited had been devoted to the study of the two general theorems: "If a circle is divided into equal parts, and if the successive points of division are connected by line-segments, the polygon so formed is a regular inserted polygon"; and "If a circle is divided into equal parts, and if tangents are drawn at the points of division, a regular circumscribed polygon is formed." The members of the class were not required to make any outside preparation, and during the period

they inscribed and circumscribed squares, octagons, and hexagons, and developed the demonstrations related to their constructions. During the exercise several types of difficulty arose.

LOGICAL PROCESSES DISTINGUISHED FROM PROCESSES OF DIRECT KNOWLEDGE

One member of the class inscribed a square in a circle by first drawing diameters perpendicular to each other. The proof following this construction should have proceeded from the equality of the angles at the center of the circle to the equality of the arcs subtended by equal angles, and so on. After the construction had been completed and proof was called for, however, it became apparent that the members of the class knew all the facts necessary to prove that they had inscribed the square, but they did not readily arrange their facts in logical order. They were not able to take the strictly analytical view and to proceed step by step to the end sought. The trouble in this case was that the spatial facts were known, and the individual items of the proof were known, but the notion of an organized logical demonstration was deficient. Thus one student insisted on starting with the fact that the arcs of the circle are equal when logically it was necessary to show first that the arcs are equal. Such errors of using the converse in proof are familiar errors in the work of geometry students. They do not bear in mind what is given and what is to be proved. It cannot be said that they are deficient in memory. They know all the facts. Their deficiency is altogether in their lack of appreciation of the demands of logic. The student is confused at times because as an observer of space relations his comments are quite right and equally obvious to him. He cannot distinguish between his knowledge of space and the logical process of demonstration.

Again, the opposite type of difficulty appeared in two cases when students were not able to pass from a logical demonstration to the spatial fact. The first of these two cases was as follows: After the square was inscribed, the question was asked, "What other figures can now be readily drawn?" The answer was given, "An eight-sided figure, by bisecting the central angles or by bisecting the arcs." The instructor put marks on the circumference assuming that the bisecting had been done. The new points were named *F*, *K*, etc. The next step in construction was to connect these new points with the old points *A*, *B*, etc., but the student who had correctly stated that the arcs should be bisected did not see how to go on. She suggested connecting *F*, one of the new points, with *K*, another of the new points. Her confusion increased when objection was raised. Evidently when she described the method of getting eight sides, she was thinking in abstract terms and could not, even with the figure before her, see at once the space relations involved. Another case of a similar type appeared when the class began to discuss constructing a hexagon. One member of the class — knowing that the division of the circumference could be made with the aid of the radius — began to work on the problem by going back to the value of π. Once started on this kind of reasoning, the student could not give it up. Even after the figure was drawn and on the board, the desire to deal with the matter in terms of π reappeared. The fact that the circumference had in no case been measured was of no avail in getting this student's mind off π. That train of ideas once started, the solution was sought abstractly and persistently in the single unproductive direction. The figure before the eyes was neglected in favor of an idea in thought which was so vivid and insistent that the student could not get away from it.

Practical Procedure and Scientific Analysis

A third type of difficulty appeared because the member of the class who began the problem of inscribing the hexagon knew that the method of procedure was to measure off chords equal to the radius, but he did not know the reason for this method. He got the result in terms that seemed satisfactory so far as the figure showed, but he was soon persuaded by the instructor that he had no evidence that his last chord was equal to the radius. He then was lost. He did not know how to go back and get the fundamental fact that he needed equal central angles. A rule of procedure is very often far enough removed from the fundamental fact so that once the mind is fixed on the rule of procedure it is very difficult to adopt the logical attitude. Even when the student saw that his rule was not a demonstration, he could not get away from the circumference long enough to think of the angles at the center. The mode of approach was confusing because it turned attention in the wrong direction. The instructor said that in other classes the fact that the central angle is the important fact is usually recognized. Perhaps it would have been better in this case to have criticized the boy when he began with a practical rule of procedure. On the other hand, the independence of the class is quite as much at stake as logical procedure, and the class undoubtedly must face cases where the wrong entrance on the problem occurs and must be overcome. The class finally discovered the equilateral triangles required for demonstration and worked out the proof, but the student who began could not. He was committed to his practical rule and could not get a point of departure suitable for the proof. He illustrated by his attitude of mind the antithesis so common in life between the practical and the theoretical method of dealing with situations.

Different Spheres of Experience in Geometry

Up to this point we have seen three spheres of experience, each of which is so different from the others that transition out of the one into another is difficult. These three spheres are first, space perception; second, an abstract system of logical steps constituting proof; and third, rules of practical procedure. That the transition from one sphere of experience to the other is a new mental process is of the first importance to the teacher of geometry. The teacher sees now that knowledge of theory, knowledge of the practical procedure, and direct percepts of space are all separate problems to be worked out; and, furthermore, he sees that the student must be trained to pass from one to the other. Educational methodology has long recognized that there are various spheres of experience, but very little explicit attention has been given to the complete enumeration of these or to carrying the student from one sphere to the other. The student is supposed to gain the power of such transition by learning demonstrations, but the fact is that transitions constitute in many cases the most confusing and difficult part of the problem. More instructorial energy should be devoted to training students in these transitions. There should be a conscious effort to view the matter from each of the possible points of view, and to pass from one point of view to the other with full knowledge of the reason for the transition. Furthermore, the student should see that the fact which is essential for demonstration is often very different from the point of highest attention to the practical operator or to the observer of space. Only through a fuller cultivation of all of these methods of thought can the student gain the advantages which come from each. So long as he is rapid and skillful only in one mode he will be limited in his resources. If he is master of all and can use all, he will be more efficient.

Danger of Reliance on Social Aids

A number of minor difficulties appeared during the lesson. Several times superficial answers were given. Thus, in the course of the discussion the question arose, What is one third of 360 degrees? One student replied successively 60, 90, 180 degrees. As the instructor waited, the student showed some confusion, and finally stopped long enough to get the correct 120. She evidently had a vague notion of the equal subdivisions of 360 degrees, and, without trying to be specific and get the particular division needed, tried several possible answers, depending on her social surroundings to check her up. This use of social checks is often most advantageous; but here it is evidently bad for the student that she could rely on the instructor to correct her carelessness. Her social dependence in this case operated to make her mental processes vague and haphazard.

Problem of Dealing with Mistakes

Another example of vagueness appeared when one of the students was asked how to draw a tangent at a point. He directed that the radius touching the point be extended, and then directed that a line be drawn bisecting this indefinitely extended radius. He probably had vaguely in view the fact that a perpendicular can be erected by laying off on a line equal distances from the point at which the perpendicular is to be erected; but he continued to be very vague about bisecting, and finally the class moved on, leaving his vagueness forever behind, corrected in the sense that the right answer was given, but uncorrected in the sense that the impossibility of his answer was never fully explained. Every error of this type furnishes an educational opportunity to find out what the student is thinking about and lead him back over the wrong path to the point where

he can take a right start. How far mistakes ought thus to be taken seriously is hard to determine. The rights of the rest of the class must be considered. The student whose vagueness is not corrected undoubtedly suffers.

Analysis controlled through Recent and Direct Experience

Students evidently do not use the general demonstrations which they have reached with any degree of confidence; they go back to the simpler and more fundamental theorems. Thus the instructor could not get the class to use the general theorems proved the day before. They insisted on going back to prove that the sides were equal because the angles were equal. The interest in simple fundamental theorems undoubtedly expresses the feeling which everyone has, that the simpler demonstrations most nearly related to direct observations are more reliable than proofs dependent on elaborate demonstrations.

At one point in the exercise the class had been discussing the relation of the side of the inscribed square to the radius. They then turned to the circumscribed square, and the question arose regarding the length of the sides of the circumscribed square. The discussion which followed showed two facts: first, the size of the circumscribed square was seen directly from the figure long before the proof of its size could be given; and second, the particular fact which was observed in the figure was the length of half of one side of the circumscribed square. This concentration on half the side of the square was plainly due to the preceding discussion of the radius, for the relation of the whole side to the diameter was quite as obvious from inspection of the figure. This incident illustrates two important facts: first, geometry even at this advanced stage uses the facts of space perception in guiding theory and in

discovering relations; and second, the part of the figure on which attention was last concentrated is likely to be the starting point of the next step in observation and reasoning. The first fact demonstrates that geometry is at all stages dependent in many ways on perception; the second shows the importance of preparation as a stage in instruction.

Difficulties of Abstraction

In marking off the points on the circumference to be used in constructing the hexagon, the student began with the point *A*. The instructor tried to get a statement of the way in which this point was selected; and after some persistence developed the correct logical statement that it is "any point." The student had difficulty in recognizing the point as indefinite in its location, because to his eye and mind it was a very definite and particular point. The instructor straightened the matter out by contrasting *A* with *B*, *C*, etc. All the later points were to the eye equally definite, but the student was led to see that *B* was definite only in respect to *A*. When he got back to *A* he could not get it from any earlier point, and so saw that it was "any point." Comparison leads to knowledge of the properties of a point, and shows the student that knowledge of properties of a point is very different from direct perception of the point itself.

Memory as a Factor in Education

All through the lesson it was evident that the students were being called on to use their memories and to select from the propositions and facts stored up in memory. A chapter could be written on this aspect of the lesson. We have of late come to regard memory work in the schools as something unworthy of recognition in comparison with reasoning and the higher thought-processes. No one who

gives the matter any serious thought can, however, fail to recognize the fact that the criticism of memory is not based on any real expectation on the part of teachers that students will be able to carry on the higher processes without an appeal to memory. Criticisms of memory are directed not against memory, but against bad forms of remembering. Again and again the members of the class were required to go back into their memories and select the theorems necessary for progress in the demonstration in hand. Sometimes they offered an irrelevant theorem. This showed lack of discrimination in selection, or it showed poverty in the stock of ideas from which the selection could be made. When we speak of working out a demonstration, it is evident that the material stored in memory must be in form to permit selection and rapid review for the purpose of facilitating selective thought. One general principle of memory which immediately suggests itself in terms of the instructor's questions is the principle of arrangement. What do you know about equilateral triangles? What do you know about lines that are perpendicular to parallel lines? These are examples of questions which were asked with a view to helping students to classify knowledge. Furthermore, the classification must evidently not be too rigid, else the proposition which is needed now to illuminate the discussion from the point of view of the size of angles will not be available later when the same fundamental fact is needed in connection with the discussion of areas. Memory must therefore contain items classified in a variety of ways. When the student goes back into his store of experiences, he must find there many propositions ready for use in many different connections. To such a flexible memory there can be no objection. To a well-ordered body of knowledge, especially if it is well-ordered in many different directions, there can be no objection. From these statements of what is demanded of

memory we begin to see how memory should be trained. If one wishes to have his students flexible and ready in ideas, then he must give them that type of memory training which will make them both ready and flexible. The problem of modern teaching is not to discard memory, but rather to train the powers of retention and recall in a better way than formerly. To object to memory is very short-sighted; to improve memory is rational.

We shall come back to this problem later. It is enough to point out here that ideas must be put into the mind with their possible relationships clearly recognized if these relationships are at some later day to be used productively in calling out the ideas. It is therefore important, when an idea is given, so to store it up in the mind that it shall be flexible and ready. One is tempted even at this stage of the discussion to point out that much of what has been said about the doctrine of formal discipline has been utterly at sea because it has not been based on this conception of the way in which ideas ought to be given. If ordinary school training does not transfer from one field of experience to another, this is not due to the inability of the human mind to transfer its training. The lack of transfer is in many cases due to the clumsy, stereotyped way in which ideas were put into the mind. The absence of general ideas and general habits of thought resulting from school work is due to poor teaching rather than to any limitations of the mind. Knowledge that does not transfer is inflexible and inert. It is badly remembered and was badly acquired. It shows that the mind is capable of taking in highly specialized ideas; it does not show that the mind is incapable of generalized experience, for generalization is seen to be dependent on the arrangement or organization of experiences. This matter will be fully discussed in a later chapter where the problem of organizing all experience so as to facilitate transfer will be the topic under discussion.

Reasoning Processes

This discussion brings us to a consideration of the psychology of reasoning processes. Reasoning is the rearrangement and recombination of ideas. Reasoning involves memory and classification of experiences and the combining of the experiences which belong together in leading to a definite conclusion. The process of thus organizing and recombining experiences is one of the most important and, at the same time, one of the most baffling for the teacher to induce in a student. There is no specific rule which can be followed in cultivating the reasoning powers. The various facts which must ultimately be fitted together come up in one mind in one order, in another mind in a different order. Often the needed fact is coupled in memory with irrelevant facts. These irrelevant facts must be rejected, and the useful facts must be recognized and held in mind until the whole fabric of the reasoning processes is woven together in a complex pattern. The teacher must stimulate to continued effort, must guide in the selection and rejection of elements, must point out that the selection of elements depends on the end sought. The end must be anticipated in general before it is reached in particular. This must all be done in such a way as to keep the student active and, so far as possible, free from dependence on the teacher and on other members of the class.

Such a description of reasoning leaves one with only general maxims such as the following: First try to foresee in a general way what end you want to reach. Next marshal all the facts you can find which are related to this end. Then arrange these facts in a progressive series. Such maxims describe what may very properly be called the general problem of the teacher. They also describe certain general mental habits and attitudes.

General Psychological Problems

We may close our comments on class observation by noting that there are certain general psychological principles suggested by a visit to any class. The individuals in the class show marked individual mental and social characteristics. One student is aggressive and talkative, interrupting on the slightest provocation, full of energy and ready to attack any problem; another is quiet, undemonstrative, shy, and embarrassed.

Again, the relation of the teacher to the students is distinctly a psychological problem. Students and teachers alike are absorbed in certain reasoning processes; they are all in the midst of psychological situations which are of great interest to the student of psychology, but which are viewed by the active participants in these processes from a wholly unpsychological point of view. The teacher will realize how direct and personal and unpsychological he usually is by undertaking, at some time when he is not absorbed in teaching, to make psychological studies of his students and their mental processes. When he is teaching, there is less opportunity to give attention to both the content of the discussion and the psychology of the student's difficulties. Later, after he has studied the psychology of the situation, he will be able to find in every class exercise opportunity to apply his discoveries.

There is, finally, the general emotional situation as it changes from moment to moment. The class and teacher in sympathy working together; the single student confused and unable to reason because he has made a mistake and is being laughed at, and, consequently, is more acutely aware of the other members of the class than he should be; the egotistical member of the class who prefers to hear himself rather than wait for ideas to justify speech — all these are interesting psychological problems, but they are general, and not especially appropriate to an analysis of geometry.

THE THEORY OF TEACHING MATHEMATICS

From observations of students we turn to books on the methods of teaching geometry. Some of these books are written without any attempt to deal with the psychology of the situation; others are full of psychological statements. For the purposes of our study we may refer to two books: one nonpsychological, the other very largely colored by psychological interests and discussions. Let the reader try the experiment of going over one of these books with a view to raising explicitly all the psychological questions that are referred to or implied in the text. Frequently the author will suggest interesting psychological problems and discussions even when the treatment in the book is wholly unpsychological.

SCHULTZE ON MEMORY

Let us consider first a passage from Schultze's "Teaching of Mathematics in Secondary Schools"[1] (pp. 10–11), in which the author deals with matters which are evidently psychological.

> In the preceding paragraph it was pointed out that mechanical memorizing is a perfectly proper method of studying the most elementary, the most fundamental facts, which are of frequent application. This is possibly the reason why the teaching is far more effective in the lower grades than later on. In more advanced work the very nature of the subjects makes mere memorizing ineffective.
>
> Our high schools, however, not only encourage memorizing, but sometimes almost force the student to adopt this as the only mode of study, for only by memorizing can he hope to satisfy the immediate demands of the school.
>
> The daily rations of mental food that the student has to swallow give him no choice; there is no time for thought, for

[1] Published by The Macmillan Company, 1912.

meditation, for judicious study; he *must* memorize. Moreover, the character of the studies leads him to mechanical work, for in spite of the vigorous denials of our pedagogues, the greater part of the curriculum is informational. It is knowledge and not power that is emphasized in most of the studies, and even subjects which by their very nature should be mastered by thinking are often made informational. For the informational method produces much quicker and more spectacular results than the slow judicious mode of study. What a fine display of learning students can make if they have been cramming conscientiously! How high the percentage they can secure in examinations! True, the after effects are sad, but who cares? As long as the boy can talk glibly about complex economic problems in terms which he does not understand, we are satisfied. What does it matter, that a year later he has not the remotest inkling of the subject, that he cannot discuss intelligently the simplest new problem that may arise!

Can we wonder that under such conditions the student never breaks away from his mechanical way of studying that he acquired in the elementary school? And can we wonder, too, that the results of our teaching become inferior in the higher grades of the grammar school, and especially so in the high school?

As one reads such a criticism of the schools he cannot help wishing that the author had been more explicit about the meaning of the term "mechanical memorizing." Just how does this differ in character from nonmechanical? And how far does the "slow judicious mode of study" involve memory? Surely a student who does not know the theorems he has passed over will be slow indeed, and probably far from judicious in his thinking. Is it true that elementary education is made up of memorizing? It is a common habit of high-school teachers without very much knowledge of the real conditions in elementary schools to give liberally of their advice about what is and ought to be the task of the lower schools. If our author would talk over this matter with some good elementary teacher, he

would find that the elementary teachers have the same problem that he has. What does anyone mean when he says that most of the curriculum is informational? Has our author measured the amount of time devoted in most schools to such noninformational studies as drill in language and to exercises in writing and speaking? Probably not; for if he had, he would hardly have made the statement which he makes. In short, our author does not contribute any very clear ideas on the value of memory in geometry and algebra. We should be left in a bad plight if we had nothing but the prejudice against memory which this passage is calculated to foster. Indeed, our author is himself so prejudiced against memory that he writes (p. 18), "The principal value of mathematical studies arises from the facts that it exercises the *reasoning power more*, and claims *from the memory less* than any other secondary school subject." The trouble is that he has got his mind fixed on a contrast between two processes, namely reasoning and memory, which are psychologically not opposed to each other at all.

Schultze on Axioms and Postulates

Another discussion by the same author relates to the difficulty of introducing the work without confusing the student by elaborate proofs and discussions which seem to him unnecessary and cumbersome (pp. 88–89).

The most fundamental propositions in geometry, such as "straight angles are equal" or "the complements of equal angles are equal," are frequently designated preliminary propositions. These preliminary propositions have certain peculiarities which make them less adapted to produce an understanding of geometry than are the theorems that follow.

In the first place, these propositions state facts which are so self-evident that the beginner does not see the necessity of proving them. That right angles are equal, or that only one

perpendicular to a given line can be drawn at a given point, are facts so obvious that their certainty does not appear to become greater by demonstrations of any sort.

In the second place, proofs of exceedingly simple facts are often difficult, and hence it is not surprising that many of the demonstrations given for the preliminary propositions are not the same simple deductions that are usually employed in geometry, but rather artificial devices. To the beginner such proofs frequently appear as unintelligible, complicated statements, the truth of which is far more doubtful than that of the theorems to be proved.

Although absolute rigor is utterly unattainable when presenting this subject in a secondary school, many textbooks sacrifice pedagogic considerations in the attempt to present the preliminary propositions rigorously. Whether or not the student can fully comprehend the presentation seems to be a matter of minor importance with some authors. "We must have rigor, absolute exactness, training in logic from the first day on, otherwise," so these dogmatists claim, "the student will be hopelessly led into the habit of slipshod thinking from which no further training can redeem him." This striving for rigor is undoubtedly responsible for the highly artificial character and the complexity of the preliminary propositions as given in a great many textbooks.

The psychology of this difficulty certainly calls for earnest attention on the part of teachers. How can a matter be clear, and yet difficult to translate into a train of logical reasoning? The answer offered in an earlier paragraph of this chapter (p. 60) is that we are here dealing with two spheres of experience. Transition from one to the other is the real difficulty. If this answer is not acceptable, then it devolves upon someone to go further, because the problem is an urgent one for the teacher. Indeed, the problem here presented raises the interesting question whether geometry of a simple type ought not to be given in the elementary schools where the simpler and less rigorous types of thought are recognized as more at home.

SCHULTZE ON IMAGERY

Another psychological problem which our author presents is that of imagery (pp. 266–268):

> The study of solid geometry strengthens the student's space imagination and his power to image space configurations, and it gives him an understanding for drawings that represent spatial objects.
>
> Altogether it seems that the utilitarian advantages are somewhat greater, but the purely cultural advantages somewhat smaller, than in plane geometry.
>
> With such restrictions the study of solid geometry will not offer great difficulty to the student. It may require a little more time and a little more study, but it does not require more intelligence than does plane geometry.
>
> One difficulty, however, against which we must guard and which we must overcome at the very start is the inability of some students to understand diagrams of solids. There are students who are able to reason logically, but who cannot imagine clearly the spatial forms which the diagrams represent. There are two ways of overcoming this difficulty, namely, the use of models and rational methods of drawing.
>
> The function of the model is to help the student in the beginning to an understanding of solid figures in general, and to make clear to him, later on, difficult drawings which otherwise he would not understand. The model should, however, not be used to supplant the drawing. As soon as the student is able to understand the drawings, the models should be discarded or reserved for the most difficult cases only. Otherwise the student will lose one of the main benefits of the study, namely, the development of his space imagination and of his faculty to understand diagrams of solids.

There are other passages, of like import, which cannot be quoted in full. These all raise at once — and in a very vivid way — the question of imagery. How does imagery differ from reasoning? Why is it more difficult to imagine solid figures than to imagine plane? Is it true that one of the

functions of geometry as taught in the schools is to cultivate the power of imagery? It is interesting to note that the experience of schools shows that students are deficient. Why should we be more deficient in this matter than the Greeks or the Japanese? Is it not because the school has left space to develop as best it can in the mind of the student without the legitimate help which would come from instruction in spatial relations all through the period of education prior to that in which the student encounters high-school geometry? If so fundamental a power as the interpretation of a drawing of a solid is lacking in high-school students, it is probable, in the light of experience, that a course in demonstrative geometry administered in the high school will cure the difficulty. Is it not rather the duty of the school to put into the elementary course at an early point some constructive geometry? Indeed, it seems very clear to the unbiased student that it is to the interest of the geometrician himself that he be persuaded to look about for ways of cultivating space imagery which are more efficient than those afforded in the logical courses now offered in demonstrative geometry.

Schultze on Formal Discipline

One problem which always turns up in educational discussions is the problem of mental discipline. Thus, our author writes:[1]

Some psychologists claim that there is no such thing as general mental discipline, that the disciplinary value pertains only to the subject studied, or to one of similar content, and that consequently mathematical study increases the reasoning power for mathematics only.

It cannot be denied that there is a little truth in the first part of this assertion, and that this theory has produced some

[1] Schultze, pp. 24–25.

reaction against the practice of defending any pedagogical absurdity on grounds of "mental discipline." But on the other hand there is a tendency among the sensational pedagogues to exaggerate and to generalize too sweepingly. Pedagogy and psychology are not exact sciences. Their results are only approximately true, and cannot be applied in the same rigorous fashion as those of mathematics or physics. If we attempt to apply them to complex problems, the limits of error are likely to become so large as to invalidate the entire results. Conclusions reached by such methods need constant verification, and must be modified if found to be contradictory to experience.

Precisely this thing happens in this widely advertised discipline theory when we apply it to mathematical teaching. Every mathematical teacher of experience has seen cases which disprove this theory. It is a common experience to see a pupil in the upper grades suddenly wake up to the meaning of mathematics, and thereby change his attitude towards study in general.

On the matter here discussed we shall later enlarge in a full chapter devoted to a review of recent discussions of formal discipline.

Smith on Formal Discipline

The importance of a rediscussion of the whole matter will be obvious when we put together two quotations from another leading author: [1]

There have been those who did not proclaim the utilitarian value of geometry, but who fell into as serious an error, namely, the advocating of geometry as a means of training the memory. In times not so very far past, and to some extent to-day, the memorizing of proofs has been justified on this ground. This error has, however, been fully exposed by our modern psychologists. They have shown that the person who memorizes the propositions of Euclid by number is no more capable of memorizing other facts than he was before, and

[1] David E. Smith, The Teaching of Geometry, p. 12. Ginn and Company, 1911.

that the learning of proofs verbatim is of no assistance whatever in retaining matter that is helpful in other lines of work. Geometry, therefore, as a training of the memory is of no more value than any other subject in the curriculum.

A few pages later the same author holds that logical training will carry over (p. 17).

In spite of the results of the very meager experiments of the psychologists, it is probable that the man who has had some drill in syllogisms, and who has learned to select the essentials and to neglect the nonessentials in reaching his conclusions, has acquired habits in reasoning that will help him in every line of work.

Schultze on Comparative Difficulty of Algebra and Geometry

Another problem on which every writer expresses himself is the character and difficulty of algebra as compared with geometry. The following quotations refer to this problem.[1]

The selection of the subject-matter for courses in elementary algebra must largely depend upon the educational advantages of the subject, which are not absolutely identical with those of geometry. Algebra requires the same accuracy of thinking, and the same, or possibly greater accuracy of detail than geometry. It may be graded as perfectly, and its introductory chapters may be made even simpler than those of geometry. The definiteness of the task given to the student, the certainty of the results, and the applicability of many of its topics to scientific or other problems are precisely the same as in geometry.

On the other hand, algebra does not require *as much* reasoning, and this reasoning is not always of the same high order as geometry. The amount of information cannot be reduced quite as much as in geometry, and some topics in algebra require a certain amount of mechanical drill. Hence, ingenuity and originality of thinking do not play quite the same rôle, and the

[1] Schultze, pp. 288–289.

knowledge of facts is somewhat more important than in geometry. Moreover, algebra lends itself rather readily to a purely mechanical treatment. Students may add exponents, transpose terms, and perform other manipulations without having a clear notion of the meaning of these operations, and the symbols involved.

Thus, while possessing most of the advantages of other mathematical branches, algebra has certain drawbacks, and the courses of study should be so arranged as to eliminate or to minimize these disadvantages.

This passage raises a whole series of psychological problems with which we shall have to deal when we have made an analysis of algebra. In the meantime we may quote once more from Professor Smith[1] on the same topic.

Smith on the Relative Difficulty of Algebra and Geometry

The child studies form in the kindergarten before he studies number, and this is sound educational policy. He studies form, in mensuration, throughout his course in arithmetic, and this, too, is good educational policy. This kind of geometry very properly precedes algebra. But the demonstrations of geometry, the study by pupils of fourteen years of a geometry that was written for college students and always studied by them until about fifty years ago, — that is by no means as easy as the study of a simple algebraic symbolism and its application to easy equations. If geometry is to be taught for the same reason as at present, it cannot advantageously be taught earlier than now without much simplification, and it cannot successfully be fused with algebra save by some teacher who is willing to sacrifice an undue amount of energy to no really worthy purpose.

This paragraph suggests a number of interesting psychological questions. Why should different stages of the study of space be separated as they now are? Why should the study of geometry continue in its present form?

[1] The Teaching of Geometry, p. 88.

If there are various kinds of geometry, then the limits of each are certainly worthy of definition. How far should direct space perception appear in the later studies of geometrical propositions, as well as in the elementary studies? Suppose that we find the studies of mensuration made in arithmetic by the ordinary elementary-school child to be quite as abstract as the theorems in geometry; will this justify our taking a different attitude than that announced in the paragraph? Why should geometry not be simplified? Is algebra made up of "simple symbolism" and "easy equations"?

SMITH ON THE APPLICATION OF GEOMETRY

As pointed out in the introductory discussion in Chapter II, geometry and its applications are different. The psychology of applications is a topic which will naturally come up again in discussing the technical subjects. We shall not be able to enter into a complete discussion of the matter in this connection, but there is a good opportunity here to get the problem clearly before us.

In his second chapter and throughout the book Professor Smith discusses the problem of the practical application of geometry. He points out that in the sixteenth and seventeenth centuries (p. 10) there were large numbers of treatises published on the subject of practical geometry. On page 11 he reaches the following conclusion:

> Out of all this effort some genuine good remains, but relatively not very much. And so it will be with the present movement [that is, the movement in the direction of applied geometry]; it will serve its greatest purpose in making teachers think and read, and in adding to their interest and enthusiasm and to the interest of their pupils; but it will not greatly change geometry, because no serious person ever believed that geometry was taught chiefly for practical purposes, or was made more interesting or valuable through such a pretense.

A further passage dealing with the same topic appears on page 74.

And as to the exercises, what is the basis of selection? In general, let it be said that any exercise that pretends to be real should be so, and that words taken from science or measurements do not necessarily make the problem genuine. To take a proposition and apply it in a manner that the world never sanctions is to indulge in deceit. On the other hand, wholly to neglect the common applications of geometry to handwork of various kinds is to miss one of our great opportunities to make the subject vital to the pupil, to arouse new interest, and to give a meaning to it that is otherwise wanting. It should always be remembered that mental discipline, whatever the phrase may mean, can as readily be obtained from a genuine application of a theorem as from a mere geometric puzzle. On the other hand, it is evident that not more than 25 per cent of propositions have any genuine applications outside of geometry, and that if we are to attempt any applications at all, these must be sought mainly in the field of pure geometry. In the exercises, therefore, we seek to-day a sane and a balanced book, giving equal weight to theory and to practice, to the demands of the artisan and to those of the mathematician, to the applications of concrete science and to those of pure geometry, thus making a fusion of pure and applied mathematics, with the latter as prominent as the supply of genuine problems permits.

In drawing this contrast Professor Smith has done us the great service of calling attention to the fact that the mental processes involved in applications of geometry are different from the mental processes aroused during the demonstration of theorems. If we recognize clearly this conclusion, we shall see the necessity of studying the processes of application in order that we may train them and in order that we may understand their value. The assumption of the school in times past has been that students will work out the applications of the theories which they learn in school in a natural and spontaneous way. There is of

course, in practical life, little justification for the pious hope that applications of science will take care of themselves. There is ample evidence that a student must be shown how to use his mental equipment before it becomes available in circumstances other than those in which it was acquired.

Let us assume that some of the applications found in the school are artificial in character. Is it not true that any general scheme of education is in this sense relatively artificial? Is not the whole period of dependent, unproductive childhood and youth a relatively artificial period? It may be said that the child who imitates his elders in a game is doing something that is highly artificial; the girl with her dolls or the boy with his carpenter's tools is certainly not making an application of his powers to any situation which can be thought of as productive. But this very artificial opportunity of employing one's powers is of the greatest advantage to the child; it is the purpose of nature during this period of dependency to furnish the child with leisure to experiment. There is no better exercise for the memory and no better exercise for the growing mind than to set up some kind of situation and face it with a view to solving its difficulties — not because the solution is going to be marketable or because it is going to modify the real world of affairs, but because it is going to give the individual poise and new equipment and new ability to carry over what he has acquired in one field into another situation which does not contain the elements of the original situation. Such an artificial situation trains one's knowledge and skill.

One reads in the educational literature of the day the statement that the school should be a real world. One reads that the child will not attack the problems of the school with any enthusiasm unless the school can be made as real as the business world is for an adult. The answer to many of these statements is that the world of action is real even when situations are merely imagined situations.

In order to be real, a situation does not need to be productive for society; it does not need to modify the physical world in any definite way. The situation is real if it calls for a mental adjustment on the part of the child or a conscious readjustment of his behavior. In this sense the applications of geometry to relatively artificial situations may be immensely real for the student who is working them out, although from the point of view of adult society they may be very artificial and insignificant.

It is enough for our present purpose if the problem is clearly before us. The solution of the problem must be sought in connection with the discussion of the place of the practical arts in school work.

Smith on the Reasons for the Study of Geometry

One final quotation from Professor Smith suggests an interesting psychological problem. On page 15 he concludes his discussion of the reasons why we teach and study geometry with the following:

> Probably the primary reason, if we do not attempt to deceive ourselves, is pleasure. We study music because music gives us pleasure, not necessarily our own music, but good music, whether ours, or, as is more probable, that of others. We study literature because we derive pleasure from books . . . . At any rate, these are the nobler reasons for their study.
>
> So it is with geometry. We study it because we derive pleasure from contact with a great and ancient body of learning that has occupied the attention of master minds during the thousands of years in which it has been perfected, and we are uplifted by it.

The student of psychology is instantly struck by the fact that Professor Smith's argument at this point is by no means fundamental. He does not go to the bottom of the matter when he says that we derive pleasure from this sort of study. Pleasure itself is an experience which needs some

explanation. There are as many different kinds of pleasure as there are different types of mental attitudes. If geometry gives pleasure, this result must be due to the fact that in some fashion or other geometry sets up forms of behavior and forms of mental activity that are in keeping with the demands of the individual's nature. No form of experience is pleasurable unless it is in some fundamental way in keeping with the demands of the individual. Therefore, when our author states that we derive pleasure from geometry, he gives a descriptive account of the situation and not an explanation of it. To offer pleasure as the prime reason for the study of geometry is to take only one step in the direction of a real explanation.

Suppose, for example, that we try two or three of the different hypotheses that might be suggested as back of Professor Smith's statement. Thus we might hold with certain metaphysicians that geometry gives pleasure because in this sphere the mind is operating in a world of its own creation. Geometry is nothing but a creation of one's own consciousness, and consequently geometry is more fully and satisfactorily understood than any other system of experience. Geometry therefore gives the mind an opportunity to work over with pleasure its own creations.

On the other hand, we may turn to an entirely different interpretation of the situation. We may say that geometry is a more concrete subject than most of the others offered in the course of study. The student can see his sensory experiences unite in a well-organized and connected system. Thus, for example, when one tries to find out the sum of the angles of a triangle, he is not at liberty to modify the real, objective facts in any particular, and the more he experiments with these facts, the more stubbornly concrete they become, while at the same time the more thoroughly reliable they are to his thinking. After he has experimented with five triangles he can go on to fifty or five hundred,

and he will always find that the result is the same with regard to the sum of the angles. Experience of this type is very concrete and objective; and the high degree of satisfaction which the student derives from this contact with a series of experiences which are uniform is the satisfaction which comes from a definite understanding of the real world.

Both of these statements would comport with Professor Smith's statement regarding pleasure, and yet they are fundamentally opposed in their teachings regarding the nature of geometry. The problem of why geometry gives pleasure is therefore a deeper problem than the mere assertion of the fact. Furthermore, there are many known cases where the study of geometry does not give pleasure to the student. The problem of how to produce a readjustment in such cases is a very urgent human problem. We shall certainly need to inquire, in such negative cases, what is the psychological character of pleasure, and what the possibility of so readjusting the situation as to produce pleasure through the study of geometry. Suppose we tell students that they will ultimately derive pleasure from tasks which at the outset do not afford pleasure, we shall be deep in the psychology of pleasure, and we shall be greatly concerned to discover the formula by which geometry can be used as an instrument for giving the ultimate pleasure promised.

The reader who has had the courage to follow the discussions of the last few pages will be convinced that it is relatively easy to raise psychological questions. The answers to some of these questions are not always easy to find. Our present purpose has, however, been served if the method of raising questions has been demonstrated. Answering some of these questions will be the work of later chapters. We shall therefore close the special treatment of geometry and turn for a time to the analysis of algebra, returning, after some discussion of algebra, to the question of the relation between geometry and the other branches of mathematics.

CHAPTER V

THE PSYCHOLOGY OF NUMBER AND ABSTRACTION

The psychological analysis of algebra must be introduced by a consideration, first, of the psychology of number, and second, by a consideration of the psychology of abstraction. Algebra is a generalized arithmetic, and as such is related historically to the science of number rather than to the science of space. This historical relation was the subject of brief comment in an earlier chapter and need not be elaborated here.

Number Consciousness a Form of Comparison

The mental process which appears in number consciousness is in essence one of the many forms of comparison. The objects to be counted are related in consciousness to some set of objects, or to some standard series of ideas, which serve as tallies. Thus, when primitive man came to possess so many cattle or tents that he could no longer remember them individually, he began to compare his possessions to convenient and more readily manageable sets of objects which served as tallies. The word "calculate" and related words show that the ancient Roman used pebbles (*calculus*, "a pebble") for the purpose in question. He looked at one sheep or one ox and set aside a pebble as a reminder of this item of his wealth. The pebble thus set aside was easy to manage, and it was a safe reminder, for it was soon found to be invariably true that if there had once been a one-to-one correspondence between tallies and

objects, there would always be a one-to-one correspondence. That is, if a pebble had been set aside for a sheep, then later there must be a sheep for each pebble.

The common series on which primitive man depended to thus remind himself of his possessions was the series of digits which he always had as convenient objects of immediate reference. The fingers exercised a significant and formative influence on the methods of counting. We can understand this influence only when we consider many facts regarding the fingers as a system of tallies. Thus we may comment in detail on one essential characteristic of the fingers which influenced the mind in making up number systems. The fingers are a limited group and require, in addition to themselves, certain supplementary devices which make it possible to use them over and over again in tallying off large collections of objects. The number system becomes, therefore, a series of multiples, and much of the terminology of number deals with this repeating of the base. Furthermore, the decimal base and the base of five which appear in many number schemes are not mathematically necessary. The base might equally well have been six or twelve or some other small, easily recognized number. In the selection of ten we see the influence of the fingers. In the struggles through which primitive people passed in developing a number terminology which should include many tens, we see the embarrassments and limitations which grew out of the limited system of tallies which the hand made available.

Words as Substitutes for Tallies

After primitive man became familiar with the advantages of a one-to-one comparison of objects with a system of tallies, it was natural that he should translate the system of tallying which he had evolved into a system of words. The number terms used by primitive peoples exhibit almost

universally the direct relation of number words to the hand-tally system. Thus one historian[1] remarks:

> The number five is generally represented by the open hand, and it is said that in almost all languages the words "five" and "hand" are derived from the same root. . . . The only tribes of whom I have read who did not count in terms either of five or of some multiple of five are the Bolans of West Africa, who are said to have counted by multiples of seven, and the Maoris, who are said to have counted by multiples of eleven.

The creation of a series of words which could be substituted for the objects used as tallies is a long process. Such a series of words has the disadvantage over a series of tallies that the word disappears as soon as it is uttered. Imagine a speaker saying over to himself, "one, one, one," and so on, as the items of his property pass in review. Evidently such a series of ones is of no use in keeping tally, because the tally system is less easy to remember than the objects taken directly. The words used in the tally system must be distinguishable, and, furthermore, each word must have a fixed place in the number series. The importance of giving a number word a fixed place in the series is seen when we observe little children who know number words, but do not know their order. A little child will count without recognition of order, saying "three, seven, one, five." A few moments later he will say "nine, six, one, three." He does not know the order of these words, hence he cannot count in any true sense.

Higher Forms of Comparison applied to Numbers

We cannot here enter into the details of the history of number terminology. Let us assume that a race or individual has learned to count, and has a developed number

[1] W. W. R. Ball, A Short Account of the History of Mathematics, p. 125. The Macmillan Company, 1893.

terminology. There are still higher forms of thought which number makes possible. Thus, suppose there are side by side two heaps of pebbles representing the Roman's count of his properties. He wishes now to combine or divide the two parts of his property represented by these two heaps of tallies. He can do this in various ways: either he can go back to the things themselves, or he can carry on the redistribution with the aid of his tallies. There is a third way which he might adopt: he might divide up the images of his possessions which he carries in memory. Finally, he might adopt the most elaborate and complex method of all: he might first translate his property into tallies, and then do his readjusting by thinking about his tallies. The method of relying on tallies proved to be the simplest. Man also found very soon that there are certain regular principles which assert themselves in the combination and recombination of tallies. The discovery of these regular principles of combination in tally systems led to the invention of counting and adding machines such as the abacus. An abacus is a mechanical contrivance to facilitate combining and recombining groups of tallies. The psychological effect of using this machine is that the individual becomes expert in rearranging sets of tallies; this is a higher process than that involved in counting.

Again, we cannot enter into the history of adding and dividing devices. We are, however, interested in the fact, for which there is abundant historical evidence, that when men found how elaborately numbers can be combined and recombined, some of them became so absorbed in this mere working over of number systems that they forgot the relation of numbers to things. Numbers became things of a higher order — they were of interest not because of what they represented, but because of their own laws of combination and recombination. We speak to-day of pure number as distinguished from applications. The expression

"pure numbers" indicates that the number system has an interest to the student of the laws of number combination, even though the process of combination and recombination is not directly related to any perceptual experience.

Numbers distinct from Systems of Measurement

Number systems and principles of number combination and recombination are, in our present-day civilization, intimately related to all kinds of systems of measurement. It should be recognized, however, that numbers are not to be confused with standards of measurement. Thus, when one uses a foot ruler to measure distance and a dollar to measure money values, he can apply the principles of number combinations in exactly the same way to two wholly different standards and to two wholly different sets of experiences. The creation of a standard foot is not a phase of number consciousness. Number is used in dealing with the foot, but the selection of the foot, and the devices adopted for applying the foot to other spaces which are to be measured, are not problems of number.

The distinction between the pure number idea and the practical arts of applying standards to objects is a distinction which needs to be emphasized by the student of education. Educational literature has at times confused these two different psychological processes, and our textbooks are full of admixtures of the two. Thus, in all school arithmetics the tables of weights and measures are given as a part of the science of number. That the tables of weights and measures are not arithmetical in character, as are the addition table or multiplication table, is seen in the simple fact that French arithmetic is the same as English arithmetic in so far as it presents the tables of pure number and number recombination, but French and English books are wholly different in the standard weights and measures presented.

The selection of a standard greatly promotes the application of number to practical life, and a standard could not be used to any advantage if there were no number system; but the intimate relation of the two does not justify the notion that they are psychologically the same.

For our study of algebra it is of the highest importance that we distinguish between measurement and number combinations. Algebra is a science which studies the laws of number recombination without any reference to standards of measurement. The student who has been studying weights and measures in the upper grades of the elementary school comes into high-school algebra and finds no tables of weights and measures. He finds some of the familiar forms of combination which he used in arithmetic, but these combinations are freed, as far as possible, in algebra from direct reference to any particular standards of measurement. Algebra does not measure; it establishes and expounds laws of combination and recombination. It is an abstract science of the laws of mathematical combination, it is not a final chapter of the ordinary arithmetic; such chapters invariably deal with applications of mathematical laws to complex measurements.

Algebra a Science of Higher Abstraction

Take, for example, the simple algebraic statement

$$a(b+c)=ab+ac.$$

This statement sets forth a fundamental and universal law of combination, but it says not a word about standards. The algebraic formula is a device for stripping the process of combination, as far as possible, of all content, and with the content removed, we face the one question, How can quantitative ideas be recombined? We are dealing here with an abstract matter of rearrangement.

This concentration of attention on the laws of combination and the neglect of all concrete aspects of situations is a form of abstraction. We must therefore study more completely the psychology of abstraction. Abstraction is a form of mental activity which begins with analysis. Through analysis we cut off in thought certain elements of a perceptual experience, and concentrate on a single characteristic or on a limited group of characteristics. We saw one type of abstraction when we were considering the geometrical definitions of lines and points. The perceived line has width and color as the observer sees it, but we do not want to consider the width or the color in geometry; we accordingly neglect them and say that a line has only one characteristic, namely, length. The point is described as having no sensory properties, no color, not even dimensions. That means that in geometry we must neglect all those sensory properties which we see when we look at real points. The neglect of certain aspects of a situation is the negative side of abstraction. On the positive side we concentrate attention on those facts which constitute the real subject matter of our science. Thus a line has length; a point has position. For geometry the laws of position and extension are the only facts worth considering in the experiences which we derive from points and lines.

The Development of Forms of Abstraction

The example of abstraction which was borrowed from geometry is by no means the simplest example that could be found. We are constantly making abstractions in our dealing with objects in that we neglect certain parts of the sensory experiences which come to us as we look at each object. For example, when talking with a person we neglect practically all of the visual experiences which come to us from the walls of the room or the objects in the room. We

thus cut off or abstract the person from his surroundings. If we are talking with a larger number of people in the same room, we include more sensory elements; we even make use of the visual images which we get from the walls, in order to adjust properly the vigor with which we articulate. Our mental and physical attitudes are very different when we are thinking of many people and when we are thinking of a single person. Our attitudes are thus seen to be relatively independent of the sensory impressions offered to us. We may therefore conclude that abstractions and activities are closely related.

The reason why we analyze our experiences and concentrate on certain selected portions of them is that we are able to react at any given moment only to one aspect of the whole situation. Those parts of the situation to which we react are of enough greater importance to us so that we recognize them more clearly in consciousness than we do the elements of the situation to which we do not react. In some cases we deliberately react for the purpose of helping ourselves to discriminate. Thus, if one points his finger in a certain direction, he finds that he can concentrate his attention and the attention of his audience very much better through this act than through any other means. The gesture of pointing is, therefore, an instrument of analysis. In the same way there are certain reactions of the eyes which aid analysis. If one points to a particular object and focuses his eyes upon that object, he brings out the meaning and value of the object on which he focuses very much more vividly than he could if his eyes simply wandered about the room. Indeed, in visual analysis, nature has coöperated by making the central part of the retina very different, in its structure and in its ability to receive impressions, from the rest of the retina. Consequently, a person who looks with fixed vision not only has the advantage of the movement by which he concentrates attention on a given object, but he also

has a clearer and more vivid group of sensory experiences from an object which is seen with the center of the retina.

Many of our movements are designed to bring us into more intimate sensory contact with the objects of attention. Thus, if after looking at an object for a time I go to it and take it in my hand, I am not only helping myself to neglect the rest of my environment and to concentrate attention on the one object through my movement, but I have also increased my sensory contact with the object. All these examples show how important are the analyses which we are constantly making of our experiences.

Words the Chief Instruments of Abstraction

We have, in addition to the various forms of movement which have been described above, an important instrument of analysis in the words which we employ. If I look at a general surface and observe at first its general characteristics, and then use a single word to designate its color, I aid myself in the analysis of the situation by the use of this word. The value of the word is not merely that I express an idea. The greatest value of the word is that I am thus aided in making an analysis of my own experience. I distinguish between the color and the other characteristics of the object through the word as an instrument of discrimination. After I have thus made analysis by means of a word, the word comes to stand in my experience for the characteristic which it designates. In later cases the word may be used to bring up in the mind a picture or image of the selected characteristic. On the other hand, in many cases the word does not recall the characteristic in any vivid way. It merely makes the characteristic available without concrete imagery. Thus, if one uses the word "blue," he can safely contrast blue with other colors, remarking to himself that blue is different from red or green.

In such a contrast of words we do not need vivid pictures of the colors themselves to become aware of the differences between the sensory qualities to which the words refer; the very difference between the names is significant for our thought. The fact that one has separate words for various color experiences records the fact that these experiences are different. Indeed, one can talk about this difference without realizing exactly what the difference is. In short, one can concentrate attention on a difference depending wholly upon two words without calling up the actual sensory images at all. To be sure, if one wanted to do so, he could usually think this difference out in sensory terms, but for the most part one saves time and energy by not trying to think out the difference in full. It is more economical for one to do his thinking and comparing in words. In all these cases we see how the mind operates through symbols, that is, through representative experiences which are substituted for direct experiences. The use of symbols is also, as seen in these examples, related to selective thought or abstraction.

In the same way there is a relation between a given word and the more general word under which it is classified. When I use the two words "color" and "blue," I do not have to stop and work out the matter in a sensory way. I have learned how to use the words as substitutes for the experience, and I know that the word "color" is a general word and that blue is classified under it as a specific term. If now I go on and use a still more highly specialized term such as "navy blue," the words themselves serve to indicate that I am dealing with a subclass. Even a person who has not seen navy blue would realize that this word designates a more specific experience than does the general word "blue."

We see by these examples how the process of abstraction is more than a process of mere analysis. The first stage of

abstraction is to neglect certain of the facts of the environment and to concentrate attention on the others; the second stage of abstraction is that in which we substitute products of our thought for real experiences, and by using these products of our thought we carry on more rapidly and efficiently all sorts of complex comparisons and discriminations.

Dangers of Abstraction

In some cases, to be sure, our symbols, or substitutes for experience, get so far away from the real sensory images that we have difficulty in carrying on our trains of thought in such a way that they are productive as guides for later contact with the world of direct sensory experiences. We then speak of our abstract thinking as too abstract, or we treat our mental processes as mere speculations. Thus, to use one more example from geometry, we may assume, with the non-Euclidean geometricians, that parallel lines meet if they are extended. This assumption that parallel lines meet is made for the purpose of comparing a wholly abstract or assumed space with the space which we know in Euclidean geometry where parallel lines do not meet. There is no difficulty whatsoever in talking about parallel lines that meet. In the world of complete abstraction, that is, in the world of thought about lines, we may think of lines in any way that seems to us to be desirable; but we cannot take the results of such thought back into the world of practice or even into the world of direct imagery. Anyone who, after speculating for a time about different kinds of possible space, should try to lay railroad rails, on the assumption that parallel lines meet, would find himself in difficulty. Speculation and practical life thus frequently need to be distinguished from each other. Indeed, the distinction is so evident that perhaps the better statement of the case is to say that the two forms of experience need reconciliation.

Advantages of Abstraction

Nor is the value of speculation to be questioned even when the results are not directly applicable to common life. Very frequently it is important that we should contrast our experiences in various ways, in order that we may learn to understand the characteristics of real experience. One who has studied non-Euclidean geometry for a time realizes very much more vividly than he ever realized before the importance of the statement that in the space which we know parallel lines do not meet. The contrast has helped him to understand in a new way what he has always seen but never fully realized.

The mental exercise which comes from contrasting possible experiences is thus seen to be of value. In the same way in many of our demonstrations in geometry we assume the contrary, and by the process of *reductio ad absurdum* we demonstrate the fact that the assumption which we have made is untenable. The argument in this case is a purely speculative argument. We assume that things might be different from real experience for the sake of coming back with greater assurance to the real experiences which will not conform to our speculation.

Special Means of Mathematical Abstraction

There are instruments of abstraction other than words; or, perhaps, the better way to put the case will be to draw attention to the fact that after language developed, other forms of experience were brought into conformity with language and were made abstract in a sense even more general than speech itself. Thus written words came to stand for spoken words. At the outset written symbols were of an entirely different type from those which we now have, but so significant is oral speech as an instrument

for abstraction and analysis that the visual symbols took on all the characteristics of spoken words. Then came a new and additional development. The written word, having taken on all the characteristics of the abstract spoken word, began to exhibit abstract possibilities of a higher order than even the oral word. The mere sight of a word now makes comparative thought possible. For example, when the two words "blue" and "color" appear on the printed page, the word "blue" is recognized as a specific term under the general term "color." This is done without any complete articulation, or any clear representation of the visual experiences to which the words refer or even of the auditory experience arising from the utterance of the word. Any careful analysis of the reading process shows that we tend to keep alive more or less the articulation which is connected with the word; but this articulation, as we shall note more fully in a later chapter, gradually grows weaker and, in some cases, gives place entirely to other and more fundamental forms of physiological activity. The fact is that we have in written symbols a new stage of abstraction which can be used in complex thought-processes in almost complete independence of sensory experiences.

From written words turn to the signs used in mathematical equations. How far we are from direct sensory experience in the use of the symbol of equality or the symbol of addition! We can talk about adding things, using the word "addition" as the instrument for expression, and we shall recognize that we have reached a high stage of abstraction; but when we write the symbol for addition and, without any complete articulation or description, instantly recognize the fact that this symbol means the assembling into a single quantity of all the quantities that are on both sides of it, then we have isolated for purposes of thought, and dealt abstractly with, a process of mathematical manipulation. The purely abstract use of addition is, of course,

possible only after one has seen the process actually carried out with a number of concrete experiences. Thus the child must add seven splints to five splints or he must add five blocks to seven blocks before he will understand what is meant by the process of addition. Little by little he can be brought to the point where he does not need to think of the actual piling together of objects in order to understand what is meant by addition. Ultimately the child can think of the process of addition and its laws quite apart from any concrete examples, as when a trained adult recognizes without detailed thought that addition increases while subtraction diminishes.

Algebra as an Abstract Science

The science of algebra can be defined in terms of the foregoing discussion as a science which examines mathematical operations in a purely abstract way. We get as far away as we can from any real cases, and we study in the most abstract form how any case could be treated if we wanted to treat it from the point of view of the adding process, or the dividing process, or the subtracting process, etc. We study the different combinations of multiplication, permutation, etc., which are feasible, with all quantities of any kind whatsoever. Whenever we come upon a symbol of mathematical operation we have the real subject matter of this science before us.

It is not enough, however, to have mere symbols of operation. There must be in every algebraic formula something which stands for, and serves as a substitute for, the things which are to be added or otherwise manipulated. For the purposes of a general science which is studying the process of manipulation, it is desirable that the quantities which are to be handled should, as far as possible, leave behind all of their particular characteristics. We do not

want to know what kind of things are to be added. We merely want to know what will happen to anything if it is added to something else. We consequently set down in our algebraic formulas the most abstract symbols of quantity which we can find, taking great pains that the symbols which we use shall have as little concrete significance as possible. We have, as a matter of fact, found it advantageous to use for this purpose the letters of the alphabet. The letters taken singly have no meaning whatsoever, and consequently they serve admirably the purpose in hand. We cannot use numbers, because numbers are expressions of a definite kind of fact, namely, exact position in the number series. It would be fatal to our study of the addition process, as such, if we used particular numbers. To be sure, numbers represent a high stage of abstraction, but they are nevertheless particular quantities in the sense that a given number means a perfectly definite relationship. On the other hand, if we use the letter *a* instead of a number, we have freed ourselves from any particular experiences, even the experience of a particular relation. It would not do to use a symbol which had even so much concrete significance as a word. Suppose, for example, that one should say in algebra that books added to books equal a library. Here we should have our attention concentrated upon books, and we could not study the addition process apart from the concrete objects which are to be added. Letters as contrasted with numbers and words represent no particular content. We might use symbols other than letters. We might use triangles and squares. The difficulty here is that if we try to use triangles and squares, we are in danger of forgetting that we do not mean triangles and squares. Forms are too interesting in themselves. We might use such a form as that of a triangle, stipulating that it represents any sort of a quantity, but there would still be the lingering impression that this triangle can represent only

other triangles. The association of space with space is too vivid to make the triangle available as an absolutely general symbol.

When a set of symbols has been stripped of all concrete content we find that attention can be concentrated wholly upon processes or operations. Furthermore, we find that when we have learned the laws of mathematical operation we can come back to real situations with greater economy of mental energy than we could effect if we held all along to the concrete facts. In other words, if our reasoning is correct, it is possible to come back to real quantities with full assurance that in so far as the conclusion depends on rearrangement it is entirely reliable, without carrying the real quantities through all the operations. Thus, if I have a real set of facts, such as income and expenditure, and wish to find out how the combination of income and expenditure will work out if I add at this point and subtract at another, I can turn my items at the beginning of the discussion into abstract form by substituting letters for the particular items. I can now carry these letters through all the various processes of combination and recombination without thinking in detail about income and expenditure as real concrete experiences. I merely think about the processes of combination and recombination. That is, I can say to myself that if I add a to b and b to c, the result for my next operation will be thus and so; I can carry on my second and third operations, using the letters all the time as substitutes for all real facts, and can after a long train of reasoning, in which I have been concerned only with combinations and recombinations, find myself in possession of a result which now can be translated back into the real facts. If I have taken a, b, and c as three quantities and have worked them over until I find that I am left with $2a + \frac{1}{2}b - 4c$, I can instantly translate these symbols back into real quantities, with the assurance that

all my manipulations have yielded a perfectly definite result. By turning quantities into abstract symbols at the outset, I have avoided all the clumsiness of reference to particular quantities. I have concentrated attention upon the processes in which I am interested, and have therefore economized enormously my mental energy; indeed, since my rules of procedure are reliable I have insured even greater correctness of thought than would have been possible if I had carried the concrete experiences along in full, for my thought-processes have been reduced to the last possible stage of simplicity.

Advantages of neglecting the Concrete

Algebra thus shows itself to be, as is all abstract thought, a most economical mental device. Once we acquire the power to neglect all the concrete facts and to concentrate our attention wholly upon the processes of manipulation, we are free from the incumbrances that come through attention to the concrete facts. Not only so, but there are certain additional advantages which can be gained from carrying on thought at this abstract level. We can represent to ourselves certain quantities which could not, as a matter of fact, be known in the concrete. Thus the student of algebra can represent the quantity which he wishes to secure by a letter such as x, and although it is for the time being an unknown quantity, he can include it in all his reasoning about operations. By including the unknown result in one's reasoning, one gets all of the advantages of having the quantity for purposes of manipulation even when he could not include it as a real quantity, because it is not known. The use of a quantity before one knows it is possible only when the student becomes so familiar with the laws of algebraic manipulation that he is perfectly sure that he is treating all quantities properly without any

reference whatsoever to their real character. Another and perhaps a more striking example is the use of imaginary quantities in algebra. Here the quantity is a pure abstraction developed by the processes of mathematical manipulation, and useful as a means of carrying these processes far enough to permit them to reach completion.

Contrast between Algebra and Arithmetic

These discussions show the enormous advantage which is gained by dealing abstractly with situations. If a student can be made aware of the fact that algebra is an economy of time and energy, he is likely to get on very much better in his use of symbols and in his appreciation of their meaning than if he is simply led to think of the algebraic processes as processes of the same type as those which he used in arithmetic. Arithmetic is a particular science; algebra is a general science. Arithmetic is limited by the fact that the use of numbers always requires attention to the number characteristics of each integer which is employed. We cannot use unknown quantities in arithmetic, simply because we have not gone far enough in the process of abstraction in arithmetic to get rid of the particular qualities which are connected with particular numbers. In arithmetic it sometimes takes a long series of operations to work out an example which a very short series of processes will work out in algebra. It is not proper, therefore, to speak of algebra as a chapter of arithmetic. Algebra takes up the processes and operations which are known to arithmetic in a form which is unknown to arithmetic. Students always have difficulty in seeing the connection between arithmetic and algebra. If there is to be a relating of the two sciences of arithmetic and algebra, the teacher must see to it that the relation is worked out explicitly for the student.

Relations of Algebra

Algebra has other relations than the relation to arithmetic. Conspicuous, and important for our study, is the relation of algebra to geometry. For the practical teacher the relation of algebra to applications in industry and science is of equal importance. These special relations deserve full consideration, and will be taken up in a separate chapter. For the present we shall be content with the account which has been given of the number idea and the process of abstraction seen in algebra, and shall turn to a brief study of algebra texts.

Comparison of Algebra Textbooks

The analysis of algebra which has been presented in the foregoing pages can be applied to some of the particular problems of teaching this subject by contrasting two textbooks — one from the middle of the last century,[1] before the present-day high-school curriculum had developed, and one[2] from the present period, during which every high-school subject is being carefully revised.

Similarity of Topics treated

The order of subjects in these two treatises is surprisingly alike. Indeed, the authors of the later book point out that they have followed the traditional order of treatment of topics. The fact that the traditional order of treatment has been maintained, in spite of the most careful revisions, indicates how completely the situation, up to this time, has

[1] Horatio N. Robinson, New Elementary Algebra. Copyrighted 1859. Preface of new edition, 1875. Ivison, Blakeman, Taylor and Company.

[2] H. E. Hawkes, W. A. Luby, and F. C. Touton, First Course in Algebra. Ginn and Company, 1909.

been dominated by the logical structure of the science. The newer book differs from the old book, however, in the fact that there are interspersed, throughout the text, chapters on the equation. In these chapters the abstract processes are directly applied to the solution of problems. Thus, in the new book, after a chapter on the process of addition, there is a chapter on simple equations. In the older book equations were not taken up until all of the processes of addition, subtraction, multiplication, and division had been explained. Indeed, in the older book not only were these processes explained and exemplified with integers, but they were also applied to fractions before the student was brought to the use of the processes in the solution of equations and problems. There can be no doubt that the more recent book has, in its free use of problems and equations, furnished the student with a means of developing his ideas of the fundamental processes. To go through half a book on a subject with nothing but abstract examples of the processes that are to be used later is a great tax upon the interest and attention of the student. The change which has been introduced is undoubtedly of value in building up and maintaining the student's insight and interest.

Emphasis on Space Material in the Newer Book

In the second place, the modern book contains certain topics which are entirely absent from the earlier book. There are a number of chapters in the new book on graphic methods and on equations that deal with space and its different relations. This emphasis upon space is in the interest of application of the science of algebra and also in the interest of clearness of presentation of the various algebraic processes studied. The student gets an idea from seeing a graphic representation of an equation which he never could get in the same vivid way if the matter were discussed wholly in

abstract terms. This disposition to show the student concrete facts related to algebraic equations is one of the most important innovations that has been made in the presentation of mathematical sciences to secondary-school students. Algebra is remote from the ordinary subjects of real experience; consequently, the discovery that space is at the same time a direct concrete experience and a means of expressing abstract relations is important to the teacher who is looking for some kind of experience which can always be used in explaining and applying algebra. Space is such material. In the older book there is very little reference to geometrical facts. To be sure, in dealing with negative quantities one finds spatial facts in the older book. There are examples about distances to the north and south which illustrate the fact that the direction in which one moves is quite as important as the distance through which he passes; but in the newer book this geometrical fact is used not merely in examples, it is used as the best and most direct means of explaining the meaning of positive and negative quantities. The principles of algebraic subtraction and addition are expounded in the newer book in terms of the straight line along which the student may move in two directions and along which he may pass from zero to positive or negative quantities. The exposition of the matter in the new book is vivid and definite, whereas in the old book the exposition was very abstract. The reader will not overlook in this connection the fact that space is well suited to this relation with algebraic processes because of its own character.

Many Examples and Explanations

A third characteristic of the new book as contrasted with the older book is the appearance of more exercises for the student to work out. Furthermore, these exercises begin in

each section with very simple examples, many of which are drawn directly from arithmetic. In this respect the two books agree; but the larger number of exercises makes it possible to develop gradually the transition through which the student must pass from simple number statements to the abstract statements of the higher, algebraical type. In the older book this transition is often abrupt, leaving the student in the dark as to the motive for giving up the number for the literal expression.

The newer book indicates a tendency to recognize the needs of the student, in that it expounds somewhat more fully the different processes through which the student is passed. Thus, when a new paragraph is introduced, the text itself shows the student why he should take the steps that are described in the rule which is to be presented. This elaborate effort to explain the processes to the student helps him to guide himself. The book becomes more and more useful as a teacher. The work of the classroom is also facilitated by the fact that more of the fundamental explanations can be comprehended by the student in private study.

Significant Omissions in the Newer Book

Finally, the newer book omits some of the more elaborate topics which were contained in the older book. Indeed, the tendency of algebras in recent years has been to eliminate those topics which are useful merely for the student of the theoretical processes. For example, there is no attention to equations with many unknown quantities, and there is little or no attention to powers above the cube. The extracting of roots for higher powers is omitted. Doubtless the practice of teachers who used the older book was much of the same type as that now followed in the more recent book. The fact that a subject was included in the older textbooks does not necessarily indicate that it was actually dealt with

in class exercises. There can, however, be no doubt, even after deducting somewhat from the formidable character of the older course, that the modern course in algebra has been materially simplified.

ARITHMETIC AND ALGEBRA

Some further considerations are suggested by the items in the preface of the later book. The authors write (p. iii), "Constant reference has been made to arithmetic in explaining the various algebraic processes." The student is often more confused than helped by reference to arithmetic. The reason for this is explained in an earlier paragraph, where the analysis of the mental processes involved in the two subjects led to the conclusion that the distinction between arithmetic and algebra is quite as important to impress upon the student as the relation between the two. We find that the necessity has been recognized from time to time of pointing out the distinction between the arithmetical processes and the algebraic processes. For example, on page 4 there is evidently an effort to help the student to understand the value of the abstract symbols. He is told that symbols enable one "to abbreviate ordinary language." Furthermore, he is led gradually to see that symbols can be even more general and abstract than those which are used in arithmetic, but this last statement is not as explicit as it might be made.

Indeed, as one reads books on algebra he wonders that mathematicians have not taken more complete advantage of the possibility of distinguishing sharply for the student between arithmetic and algebra. If algebra is nothing but the last chapter of arithmetic, as the student would naturally assume from many of the statements which are made in the text, why was algebra not introduced in the arithmetic books themselves? There is some tendency to take algebra

down into the elementary classes. If this tendency is to grow, would it not be well to point out explicitly to students the economy of this mode of treating mathematical operations? The distinction between algebra and arithmetic is quite as significant to the elementary student as it is to the mature student of the subject, and this distinction may advantageously be brought out. For example, on page 7 in the book in hand the statement is made, "In algebra numbers are represented by one or more numerals or letters or by both combined." Would it not be better at such a point as this to indicate that not only numbers but whole series of numbers are expressed by the letters? In the next paragraph, for example, it is said:

> Precisely what numbers $4xy$ and $2x + 3$ represent is not known until the numbers for which x and y stand are known. In one problem these symbols may have values quite different from those they have in another. To devise methods of determining these values in the various problems which arise is the principal aim of algebra.

This is the opportunity to tell the student that the chief business of algebra is to avoid determining from step to step the exact values of these different symbols. It is the business of this science to carry on the reasoning processes with the symbols in the most general form possible. The final discovery of a particular quantity is of less interest to the science of algebra than the correct manipulation of quantities in processes which may ultimately lead to results, but are capable of study long before the result is obtained. To describe the processes of algebra as though they were similar to those of arithmetic is to confuse the student. He gets the impression that the use of letters is another refinement of the teacher's methods of giving him unnecessary problems to solve. It would be much more psychological and helpful for the teacher to let the student understand

that he is now acquiring a new and more general mode of manipulating quantities. As he studies the science of algebra he must aim to criticize processes and results not from the point of view merely of the ends which are to be obtained, but also from the point of view of the methods which he adopts at every step.

Applications

One further comment in the preface of the newer book is of interest:

> Some informational problems have been included, but wholly with the intention of stimulating interest and not with the idea that such problems are practical, or that they arise in everyday life, or that it is the function of algebra to teach history, geography, or other subjects.

This tendency to include in the problems facts of ordinary experience appears also in the older books. There evidently has been all along some desire to make algebra seem to the student to have connection with concrete life. The artificiality of many of these problems is, however, very striking. For example, on page 38 we get such an example as this: "The combined horse power of a Mallet Compound freight engine (Erie Railroad), of a Pacific passenger engine (Pennsylvania Railroad), and of a Baltimore and Ohio electric tractor," and so on. Imagine the student trying to get from this kind of a problem any inspiration for his science. There is very little wonder that writers on mathematics find themselves in difficulty with problems of application when this sort of thing is developed in the minds of teachers as a means of showing students the interesting side of the science. The student knows perfectly well that these three engines will never get together for purposes of real cooperation. He knows that the use of these different names is merely a device to make him readjust the problem in

algebraic terms. He will have to convert engine No. 1 into letter a and engine No. 2 into letter b, and so on, before he can go through the ordinary algebraic processes. This translation from one set of terms into another is, on the whole, good training for the student who has to use the abstract terms, but he cannot help feeling the artificial character of the original statement which is supposed to be nearer to practical life than the letters which he employs. The situation is bad because there are materials which are capable of employment in algebra borrowed directly from the sciences and so real and significant that they avoid all the artificiality of examples like the one just cited. The trouble is that algebra is usually taught at a time in the high school when examples from the sciences cannot be readily borrowed. In this connection note that our authors make this statement (p. iv):

> A large number of "motion" problems are given which, with many problems based on physical ideas and physical formulas, should give much desirable correlation with the subject of physics. A very large number of problems are based on geometrical ideas, and as the needs of geometry largely decided the choice of the exercises in radicals, it is hoped that a close correlation of algebra with geometry has been secured.

Why should not material of this sort, which is perfectly natural and legitimate, be used to the exclusion of the artificial problems that have really no connection with either science or life? If necessary, let us precede the algebra problems by an explanation of these phenomena which can be adequately dealt with by algebraic methods. It may prove to be wise for us to develop some simple notion of mechanics in the first years of the high school and postpone algebra to a later period. In an earlier historical introduction to this discussion the reasons have been suggested why a postponement of algebra would, on the whole, be very legitimate. In any case space is evidently from now on to

be used, even if algebra stays in the first year; the device which the modern author has adopted, of introducing graphs as a part of the algebra course, will help to cure in a measure the abstractness of the algebra course.

Observations in an Algebra Class

Before attempting any discussion of the conclusions to be drawn from our studies, let us turn to a brief study of students and their work in class. Observations made on students who are attempting to solve problems in algebra always make the layman wonder what the writers on mathematics mean by the repeated assertion that algebra is easier than geometry. Probably the assertion is correct when some of the simpler formulas of algebra are compared with the later propositions in geometry, but such a comparison is obviously without value. Certainly when one comes to the more complex problems in algebra, there is so much of a demand upon the powers of abstraction, and so much confusion which can arise from the many steps which need to be taken in solving a problem, that one understands very readily why students fail in this course.

Great Variety of Mental Processes observed

For the purpose of getting material that should parallel the observations made in the class in geometry, the writer attended a class in which the students were factoring and using the methods of factoring to solve equations. At the beginning of the class they factored some compound fractions and reduced them to simpler forms; toward the end of the class they factored certain equations and found the roots of the equations. In all these cases it was evident that the solution of the single problem involved a number of different operations, and the successive operations involved

references to many principles of mathematical manipulation which the student had to use correctly or he was in trouble later. Thus, in clearing a compound fraction he must first discover a common denominator for the fractional elements. Second, he must multiply each fraction by the factor which would reduce it to the common denominator. This involved a knowledge of all the principles of division and multiplication, including the correct manipulation of signs.

Absence of Concrete Checks

Furthermore, each step is an abstract step; that is, it is not guided by any observable starting point or any reference to a conclusion which can be seen and anticipated. This characteristic of algebraic operations may be made more obvious by contrasting algebra with geometry. When one is solving a problem in geometry he knows that he is working with triangles or with rectangles and he can constantly come back in the development of his reasoning to the concrete space figure with which he is dealing. In algebra, on the other hand, the successive stages of the process are not referred back to any concrete experience; the second step leaves the first behind, having substituted for the first situation a relatively new set of facts. In like manner the third stage leaves the second behind. The whole reasoning process is thus carried on without any concrete point of reference. Sometimes, in order to meet this situation, the instructor calls upon the students to write out each step completely. The advantage of writing out each step is evidently this: it makes it easier for the student to see his way through the succession of processes. He can compare the result which he has reached at the end of the first step with the requirements, and then he can proceed to the second step with some degree of assurance. This writing out of each individual step is, however, very cumbersome;

and instructor and students alike realize the possibility of curtailing the work by carrying on some of these processes in the mind, rather than working them out completely and recording them on the blackboard or paper. On the other hand, if one of these steps is performed mentally, there is grave danger that the result obtained will not be reliable for the next stage of reasoning. Every algebra class furnishes abundant illustrations of the uncertainty of a conclusion which is reached through a series of unrecorded mental operations. There is, therefore, a constant conflict between certainty and precision of procedure, on the one hand, and rapidity and economy of effort, on the other.

In the second place, a process of reasoning may be correct in itself, but may not help in reaching the final solution, because it leads in the wrong direction. For example, if one is rearranging an algebraical quantity for the purposes of factoring, he may rearrange it in such a way that he cannot easily extricate himself from the new form in which he has cast his expression. He may get his quantities on the wrong side of the equation in such a way that it will not be easy to factor them; or he may get all of his quantities on one side of the equation where their negative character will confuse, whereas if he had assembled them on the other side of the equation, the proper quantities would have been positive. Very frequently there is a single additional operation (if one thinks of it) which will extricate him from these difficulties, but more often one must turn back and begin over. One is required, therefore, to look ahead as intelligently as he can. He must take the step which he is taking at the present moment with a view to following it up by a second and third productive step later. This constant effort to anticipate the consequences of one's reasoning requires a range of attention which is not required in the geometrical processes in the same degree, or if it is required in the geometrical process, it is always supported

by a much more concrete view of the end toward which one is working. One knows in geometry something about the theorem which he has to demonstrate. He does not know in the same concrete way in a problem in algebra the conclusion toward which he is working. There is therefore at the moment no immediate check which will guide him in arranging his quantities.

Confusion arising from Absence of Checks

This last statement helps us to appreciate what is meant by students when they say that they do not know what to do next. They can do something that would be entirely correct, but they feel very sure that correctness is not all that is wanted. What they do not know is how to proceed in such a way as to aid themselves in reaching a solution of the problem. There is an element of guesswork in the solution of an algebra problem which is very confusing to a student, especially if he is carried forward in the course too rapidly. This type of confusion is so common in algebra that it explains many of the failures in this subject. How an instructor knows, or how some other member of the class knows, just how to proceed is a mystery to the student who is not able to see far enough ahead to determine how he ought to proceed. Factoring, for example, is all right as soon as one gets the quantities put together in a recognizable form, but the ingenuity which textbooks and instructors seem to be able to exhibit in putting quantities together in such a way that they will not be recognizable as familiar quantities for factoring is baffling to the ordinary student. It would be interesting for some teacher of the subject who is also interested in the mental processes of his students to try to enumerate the different ways in which students may be right in the single operations which they perform, and yet wrong in their solution of the problem as a whole.

In addition to the possibilities described in the last paragraph of going astray in the manipulations, there are infinite possibilities of actual error. One forgets how to remove a parenthesis or how to transpose quantities, or, through carelessness, omits to apply the principle which he knows well enough in theory. The teacher of algebra is constantly working, therefore, to keep alive and in operation a long list of principles of operation which students are constantly omitting. The omission means an error, and an error means failure to reach a solution.

Examples of Typical Difficulties

The observations made in a single period exemplified all of the difficulties described above. Perhaps the most vivid presentation of the observations will result from an enumeration of errors; that is, of the principles that were omitted or violated. The list would probably be longer if the writer had been more expert in this type of observation. He noted, however, the following cases. The students often failed to keep in mind a long series of principles necessary to guide in manipulating the signs of different quantities. They forgot that a negative sign before a parenthesis works certain changes in the quantity within the parenthesis. They lost sight of the effect produced upon signs by transposition from one side of the equation to the other. Another type of error arose from a failure to keep in mind the processes which control the different combinations of quantities. They made repeated mistakes in addition, subtraction, multiplication, and division. Again, they did not see the various familiar combinations which make it possible to get rid of undesirable quantities on both sides of the equation. They did not always remember that the management of the two sides of an equation or of the two members of a fractional expression calls for a like treatment of both of the

elements in the operation. They committed an error of omission in that they did not show the boldness to try experiments in the rearrangement of quantities. They were not patient enough to work out this rearrangement until they could see ahead a method of getting a conclusion. Their hesitation was evidently due in some cases to a recognition of the fact that if they eliminated some of the quantities they might lose just the one needed to turn their factors into the familiar factors needed for later manipulation. They frequently made the error of trying to economize by carrying on processes mentally when the more deliberate written statement of the same problem showed that they knew the principle of procedure.

Method must be Adapted to Particular Difficulties

Perhaps some reader of the foregoing paragraph will ask, What is the use of laboriously cataloguing all these different types of error? They are all alike, in that they show inability to solve the problem. Give the erring student more examples; that is the one and only cure for all these difficulties. Our answer to such a comment is that the cure is not one and simple. The student of algebra is often lost in the maze of complexities. At each turn he is confronted by a single difficulty. His difficulties need to be disentangled, and one by one the kinds of processes which he needs must be picked out and definitely dealt with. If some teacher of algebra would make out a card catalogue of the kinds of mental processes involved in the solution of all algebra problems, and would then arrange his subject matter to meet these difficulties, he would probably break away from the traditional order of that subject more than any of the textbooks have ventured even in the latest period. He would also give to the subject an educational character

which it does not now have. At present we let students flounder in a sea of mental difficulties until some learn to swim and many drown. We tell them from time to time when they are going down, and sometimes we rescue them when we see them sinking, but we have little advice for them in regard to the best methods of swimming. Our algebra instruction is on the whole a crude exhibition of the method of "try, try again," when it ought to be the most completely supervised of any of the subjects, especially if it is to continue to hold its place as a subject commonly required.

CHAPTER VI

THE REORGANIZATION OF MATHEMATICS

REORGANIZATION EVIDENTLY UNDER WAY

In a vigorous paper Superintendent Morrison[1] has recently advocated the complete rearrangement of high-school mathematics. Algebra and geometry, he contends, must be taught (if at all) so as to function throughout the student's life. If the student is especially interested in commerce, his mathematics must be so organized as to contribute to his practical training. If the student is pursuing agriculture, his mathematics are to be of a type which shall serve that interest.

Other evidences are not wanting that high-school mathematics are approaching a period of radical revision. There is evidence which, from the point of view of the school administrator, is of a very practical type. Statistics show that in the more progressive high schools algebra is receding to a position of less importance than it formerly held.[2] The colleges are requiring less mathematics than ever for admission; and the individual student who fails is becoming more insistent than ever that he be allowed to go on with other subjects.

SUPERVISED STUDY

In the meantime, two experiments are under way which promise relief, and to these we turn for their contribution to our psychology.

[1] Thirteenth Yearbook of the National Society for the Study of Education, pp. 9–31. University of Chicago Press.

[2] *Science*, 1912, *N.S.*, Vol. XXXVI, pp. 587–590.

The first experiment is in the direction of more supervision of study by the teacher.[1] Students are not being sent home with problems to solve; they are working out the problems in class with the teacher. The mistakes which they make are being checked through social criticism.

The value of social criticism as an instrument in education cannot be exaggerated. To be sure, there is something artificial from the point of view of the science itself in interposing between a student and the solution of his problem criticism by another person. For example, when the teacher says, "Be careful, have you removed that parenthesis correctly?" the scientific training of the student has been so far forth interrupted that a human check has been substituted for a check of the strictly algebraic type. If the child becomes dependent on social help in the solution of all his problems, the substitution of social training for independent learning may become a serious drawback. On the other hand, learning through proper supervision is economical and rapid beyond all other methods.

Psychologically, social interference in mental processes is of various types. There is social interference which terrorizes and distracts. There is social interference which aids one over a difficulty without clearing up the difficulty. There is social interference which teaches deliberation. There is social interference which makes for economy in mental operations by pointing out methods of procedure. In short, there is a whole psychology of the relation between student and teacher. This is not the point at which this particular psychological problem can be discussed at length; but it is germane to the present discussion to note that the right kind of supervision or social coöperation cannot be expected unless teachers study the problem of how students study, and how they ought to study. We shall come back

[1] Article by E. R. Breslich in Thirteenth Yearbook of the National Society for the Study of Education, pp. 32–72.

to a fuller discussion of methods of study in a later chapter devoted entirely to this problem. The student needs help in algebra more than in most subjects, because the mental processes involved in this study are so abstract and complex that it is extremely difficult to find one's way without much guidance.

One reciprocal advantage of such a system of supervised study is that the teacher discovers the details of students' mental processes more fully than under the usual conditions of recitation work. Errors are corrected before they become chronic, and the waste that follows upon confusion is avoided.

Smith on Applied and Combined Mathematics

A second type of reorganization reaches into the subject itself and undertakes to reorganize the matter dealt with in these courses. Of the various internal reforms within the mathematics courses there are two which have gone far enough to attract adverse criticism. We may therefore quote at length the passages in which these matters are discussed by Professor Smith.

[P. 74] And as to the exercises, what is the basis of selection? In general, let it be said that any exercise that pretends to be real should be so, and that words taken from science or measurements do not necessarily make the problem genuine. To take a proposition and apply it in a manner that the world never sanctions is to indulge in deceit. On the other hand, wholly to neglect the common applications of geometry to handwork of various kinds is to miss one of our great opportunities to make the subject vital to the pupil, to arouse new interest, and to give a meaning to it that is otherwise wanting. It should always be remembered that mental discipline, whatever the phrase may mean, can as readily be obtained from a genuine application of a theorem as from a mere geometric puzzle. On the other hand, it is evident that not more than 25 per cent of propositions have any genuine applications outside of geometry,

and that if we are to attempt any applications at all, these must be sought mainly in the field of pure geometry. In the exercises, therefore, we seek to-day a sane and a balanced book, giving equal weight to theory and to practice, to the demands of the artisan and to those of the mathematician, to the applications of concrete science and to those of pure geometry, thus making a fusion of pure and applied mathematics, with the latter as prominent as the supply of genuine problems permits.

[Pp. 84, 85] From the standpoint of theory there is or need be no relation whatever between algebra and geometry. Algebra was originally the science of the equation, as its name indicates. This means that it was the science of finding the value of an unknown quantity in a statement of equality. Later it came to mean much more than this, and Newton spoke of it as universal arithmetic, and wrote an algebra with this title. At present the term is applied to the elements of a science in which numbers are represented by letters and in which certain functions are studied, functions which it is not necessary to specify at this time. The work relates chiefly to functions involving the idea of number. In geometry, on the other hand, the work relates chiefly to form. Indeed, in pure geometry number plays practically no part, while in pure algebra form plays practically no part.

In 1637 the great French philosopher, Descartes, wishing to picture certain algebraic functions, wrote a work of about a hundred pages, entitled "La Géométrie," and in this he showed a correspondence between the numbers of algebra (which may be expressed by letters) and the concepts of geometry. This was the first great step in the analytic geometry that finally gave us the graph in algebra. Since then there have been brought out from time to time other analogies between algebra and geometry, always to the advantage of each science. This has led to a desire on the part of some teachers to unite algebra and geometry into one science, having simply a class in mathematics without these special names.

It is well to consider the advantages and the disadvantages of such a plan, and to decide as to the rational attitude to be taken by teachers concerning the question at issue.

[Pp. 89–90, 91] It is therefore probable that simple mensuration will continue, as a part of arithmetic, to precede algebra, as at present; and that algebra into or through quadratics will precede geometry, drawing upon the mensuration of arithmetic as may be needed; and that geometry will follow this part of algebra, using its principles as far as possible to assist in the demonstrations and to express and manipulate its formulas. Plane geometry, or else a year of plane and solid geometry, will probably, in this country, be followed by algebra, completing quadratics and studying progressions; and by solid geometry, or a supplementary course in plane and solid geometry, this work being elective in many, if not all, schools. It is also probable that a general review of mathematics, where the fusion idea may be carried out, will prove to be a feature of the last year of the high school, and one that will grow in popularity as time goes on. Such a plan will keep algebra and geometry separate, but it will allow each to use all of the other that has preceded it, and will encourage every effort in this direction. It will accomplish all that a more complete fusion really hopes to accomplish, and it will give encouragement to all who seek to modernize the spirit of each of these great branches of mathematics.

There is, however, a chance for fusion in two classes of school, neither of which is as yet well developed in this country. The first is the technical high school that is at present coming into some prominence. It is not probable even here that the best results can be secured by eliminating all mathematics save only what is applicable in the shop, but if this view should prevail for a time, there would be so little left of either algebra or geometry that each could readily be joined to the other. The actual amount of algebra needed by a foreman in a machine shop can be taught in about four lessons, and the geometry or mensuration that he needs can be taught in eight lessons at the most. The necessary trigonometry may take eight more, so that it is entirely feasible to unite these three subjects. The boy who takes such a course would know as much about mathematics as a child who had read ten pages in a primer would know about literature, but he would have

enough for his immediate needs, even though he had no appreciation of mathematics as a science. If any one asks if this is not all that the school should give him, it might be well to ask if the school should give only the ability to read, without the knowledge of any good literature; if it should give only the ability to sing, without the knowledge of good music; if it should give only the ability to speak, without any training in the use of good language; and if it should give a knowledge of home geography, without any intimation that the world is round — an atom in the unfathomable universe about us.

The second opportunity for fusion is possibly (for it is by no means certain) to be found in a type of school in which the only required courses are the initial ones. These schools have some strong advocates, it being claimed that every pupil should be introduced to the large branches of knowledge and then allowed to elect the ones in which he finds himself the most interested. Whether or not this is sound educational policy need not be discussed at this time; but if such a plan were developed, it might be well to offer a somewhat superficial (in the sense of abridged) course that should embody a little of algebra, a little of geometry, and a little of trigonometry. This would unconsciously become a bait for students, and the result would probably be some good teaching in the class in question. It is to be hoped that we may have some strong, well-considered textbooks upon this phase of the work.

The Foregoing Argument answers itself

Are we not in a position to recast the geometry of the Greeks and the algebra of the Arabs into an instrument of modern intellectual training? May we not urge this change the more freely when we have come to recognize the importance of both algebra and geometry and the contribution which each is ready to make to intellectual life? The very fact that we have taken both into our circle of subjects to be taught shows that we are better off than was Euclid, or the early European teachers who started our present tradition.

Various Branches of Mathematics involve fundamentally Different Mental Processes

The psychologist is of course not equipped to work out the change. He may, however, venture to suggest certain principles which will have to be taken into account when the change is made. The first of these principles is that arithmetic, algebra, and geometry each represents some forms of mental activity not included in the others. No one can make a psychological analysis of these sciences without recognizing the distinctive character of the mental processes involved. The earlier chapters of this book have been devoted to the description of the mental processes peculiar to geometry and algebra. The principle has not been justified in full for arithmetic because arithmetic does not fall within the scope of this book; however, considerations were presented which adequately cover even arithmetic.

All Mathematics Abstract

Second, all mathematical sciences represent abstract forms of thought. Number is an abstraction derived from, but not identical with, the system of tallies from which it originated. Space, as treated in geometry, is something other than the space system which we build up through touch and vision. The line which is studied in geometry is an abstraction and belongs in an abstract scheme of thought; so is the surface and solid. Algebra is evidently a system of abstractions. As a system of abstractions mathematics can never be identified with its applications. The justification for a system of abstract thought is that it evades some of the complexities of real concrete situations and furnishes a means of thinking one's way through the real world with greater economy. The system of abstraction deserves, therefore, some treatment for its own sake.

Training in Application required

Third, it is contrary to experience to assume that students can apply mathematics to the other sciences or to the practical affairs of life unless they are trained to see mathematical relations in other forms than those in which they are commonly presented in the schools. The student who knows the abstract demonstrations of geometry, but does not realize that knowledge of space is involved in every manufacturing operation, in every adjustment of agriculture and practical mechanics, is only half trained. Application must be a phase, and an explicit phase, of school work. Application is as different from pure science as pure sciences are different from each other.

Space Typical Form of Relational Experience

Fourth, the direct perceptual experience which is most closely related to all types of mathematical thought is space. Space, because of its character as a relational type of experience, is not only itself a natural subject of mathematical consideration, but is also capable of representing in graphic form those mathematical relations which are usually represented in letters and numbers. Space is therefore strongly suggested as an instrument for both the exemplification and the expression of mathematical ideas. Furthermore, by virtue of the intimate relation of space perception to mechanics, space seems to be a good instrument for the training of students in application of mathematics. While thus emphasizing the significance of space for mathematics, it is proper once more to emphasize the historical fact that in our Western civilization the science of space is prior to all other phases of mathematics. It is altogether probable that this fact will shortly be recognized in the elementary course.

Mathematical Subject Matter in Need of Regrading

Fifth, both algebra and geometry contain simple and complex principles. There is no reason why the simpler principles of both branches of mathematics should not be recognized as more suitable for beginning students than an exclusive diet of either algebra or geometry. The conclusion that one or the other is harder or easier when the two subjects are taken as wholes is unfortunate. The experience of schools does not justify the statements of specialists that algebra is easier than geometry. The fact is that some parts of one are hard for beginners and other parts are simple. The best arrangement of subjects would be to bring together all the simpler mathematical principles and lead up from these to the complex problems in both fields.

Mathematics as Training in Modes of Abstraction

Sixth, no student will know what mathematics is until he realizes the great economy of mental energy which this form of experience makes possible. The student of high-school age should certainly be taught the value of abstraction, as well as the methods of abstract reasoning.

Practical Implications of General Principles

These principles, all of which grow directly out of the discussions of the foregoing chapters, seem to the writer to call loudly for a first-year course in high-school mathematics which shall lay emphasis on space, shall include application but not become so absorbed in applications as to obscure the principles of abstract reasoning, shall include the simpler principles of both algebra and geometry, and shall train the student in an appreciation of the value of symbols.

If this book were intended for teachers in the elementary schools, it would advocate a course in form study early in the grades, and it would advocate the use below the high school of some of the economical methods of mathematical reasoning taught by algebra.

The only one of these conclusions which has not been fully supported in the foregoing pages is that referring to applications. The issues here involved are too broad to be dealt with in terms of mathematics alone. Every course in the curriculum raises the same kind of problem. We shall therefore let this question rest for the moment, with the promise that the psychology of applications will come up again. These early chapters on mathematics have carried enough of the general burden of introducing the reader to the problems of high-school education. We shall turn, therefore, to the next general topic on which psychology is prepared to speak, namely, the psychology of language.

CHAPTER VII

THE PSYCHOLOGY OF LANGUAGE

Secondary Course traditionally Literary

The secondary-school curriculum has throughout its history been dominated by language courses. Whether these courses have been given for the sake of acquainting the student with foreign literatures, as in the period of the Renaissance, or for purely disciplinary reasons as during the later period when the cultivation of a Latin style was thought to be the highest form of training; whether the training has been in a foreign language as in earlier days, or largely in the vernacular as at the present time — language has, in one form or another, been the favored course of study in all secondary and higher schools. If one considers the merely quantitative fact that at the present time about 36 per cent of the courses offered in the secondary schools are courses either in the study of the vernacular or in the study of a foreign language,[1] he recognizes the importance of sound views with regard to this phase of secondary education. Indeed, it may be said that the proper organization of language courses is, if possible, a problem even more urgent than the problem of organizing algebra and geometry. The practical difficulty arising from student failures is not as great in the language courses as in mathematics. In some quarters, to be sure, Latin shares with mathematics the doubtful honor of being the course through which freshmen are eliminated from school. The characteristic difficulty

[1] Unpublished study of North Central Association reports from approved high schools.

that appears in language instruction is the difficulty which arises from the fact that students spend an enormous amount of time on these courses and carry away what is acknowledged to be a very meager result. An American high-school graduate who can really read Latin is a very rare product. In the modern languages students study the courses for two or three years and are not able to read a simple text or understand a simple conversation. Even in the vernacular the complaint is heard again and again from English teachers that students who have been studying English all their lives are unable to write a coherent paragraph or to understand even the best-known examples of English classical literature. The net outcome of the time and energy devoted to language is hardly to be compared with the net outcome which is demanded of students in science courses. If students should study the natural sciences for two or three years and at the end of the course have nothing substantial to offer as the outcome of their endeavor, certainly the natural sciences would not be able to maintain themselves in the curriculum. When, accordingly, one hears a teacher of German or French contending that two years is too short a time to accomplish anything for a student in that language, he realizes the necessity of canvassing carefully the language courses. Certain it is that many students will not be able to spend more than two years on German; and if the course is not organized at the present time in such a way that these two years will yield a useful result, then there ought to be a reorganization of the course.

Justification demanded for Emphasis on English

In classifying English and foreign languages together for the purposes of the following discussion some confusion is undoubtedly created, because in general the instruction which is offered in foreign languages is different in its

character and in its purposes from instruction offered in English. On the other hand, there can be no doubt that the large amount of attention which is being given at the present time to English is to be explained as a survival of the traditional devotion to the language subjects. English has, in the present period of reaction against the classics, enjoyed the advantage of being acceptable to both parties in the classical controversy. English has been acceptable to the defenders of classical training because they think of English as a body of literary material, and regard it as proper to use in defense of English most of the arguments which they have developed in defending their own subjects. On the other hand, the students of science are also interested in seeing English receive a good deal of attention because they believe that it represents a departure from the classical traditions and from the devotion to formal instruction in foreign languages. English has therefore gone on its way undisputed. It has come to be the only subject in the secondary-school curriculum which is recognized by everyone as a suitable subject to be required of all students. Signs are not lacking that a day of reckoning will come for English also. When the teachers[1] of this subject themselves are prepared to criticize it as severely as they do, there is danger that representatives of other departments will discover its weaknesses. Just as soon as the weaknesses of present-day English courses are clearly pointed out, there will inevitably come a demand for a justification of the large amount of attention which these courses now receive. The classical languages have for some years past been on the defensive. The modern languages have been growing in importance, and yet they also are being questioned by those who are interested in the possibilities of developing a scientific and technical curriculum; so that

[1] C. S. Duncan, "A Rebellious Word in English Composition," *English Journal*, March, 1914, p. 154.

on all sides the language subjects will have to canvass carefully the question of the amount of time which they can legitimately demand, and they will have to supply an educational defense for themselves much more critical and complete than anything which has been supplied up to this time either by tradition or by the concrete evidences of success which have attended instruction in these subjects.

The General Psychology of Language

As in our earlier studies of mathematics, so here we may very properly introduce the consideration of detailed problems by a review of the contributions which psychology has to make. This is the more needed because there is in the minds of most uncritical thinkers a great deal of false doctrine about the mental processes connected with words and their interpretation. Indeed, it is only during the last fifteen years, since Wundt's work in his "Völkerpsychologie" began to be widely appreciated, that anything like an adequate psychological treatment of language has been current.[1]

Earlier Psychology emphasized Images

The earlier descriptions of the mental processes involved in the use of language all started and ended with the assumption that words get their meanings by association with images in the speaker's mind or in the mind of the

[1] Wilhelm Wundt, Völkerpsychologie. Engelmann, Leipzig, 1900. Unfortunately there is no English translation of this great work. Readers who do not command German are referred to the following brief discussions in English: Wundt, Outlines of Psychology (translation published by Engelmann. Only the third English edition is complete); G. F. Stout, Manual of Psychology (Hinds and Noble); G. F. Stout, Groundwork of Psychology (Hinds and Noble); Charles H. Judd, Psychology, General Introduction. It is the more important that teachers should become acquainted with these summaries, since the educational writings of recent years have curiously omitted discussions of language, so absorbed have they been in sensations, instincts, emotions, and the like.

listener.[1] When one hears a word, we have been told, he calls up a train of pictures, and these are the really important mental facts. The word is a mere clue, a kind of key to the storehouse of meanings. There has been at all stages of the discussion a very large disregard, almost a contempt, for the word as distinguished from the associated image. Indeed, the word has been so much neglected that one obvious fact has been overlooked in most of the discussions. This obvious fact is that speech in all of its manifold forms is more ~~than a mere~~ train of ideas; it is a definite and important kind of behavior. There is a movement of some muscles of the body present in every form of speech and reading. If one articulates a word, there is a most elaborate coördination of the muscles of respiration, of the vocal-cord ~~region, and of the~~ mouth. If one reads, there are eye movements and incipient movements of the muscles of articulation. If one listens, there are adjustments of the head and ears, and active vocal tendencies to repeat what one hears, and active forms of inner reactions of assent and dissent. Even if it were true that words always call up images, it is infinitely more true that words are forms of behavior, and their value in individual life can be understood only when this behavior-aspect of the matter is duly considered. Furthermore, there is ample ground in personal experience for skepticism about the statement often made that words call up trains of pictures. The few faint images which flit through the mind as one reads a page of meaningful discussion are by no means the important facts in mental life which some psychologies have tried to make them. When one looks into his own mind he finds wealth of meaning and meagerness of imagery. When a false psychology tries to persuade the observer

[1] Locke's "An Essay concerning Human Understanding" (1689–1690) set the example of English writers in this respect. See also Berkeley's "A Treatise concerning the Principles of Human Knowledge," 1710.

that the images pass through the mind too rapidly to be noted, he has a right to ask for a more vital and adequate explanation of this most important form of experience.

Language a Form of Behavior

There is one other aspect of the matter which calls for comment before we turn to the study of words as forms of behavior. Up to this time the breach between words and practical activities has been complete. The teacher of manual training has scorned words, and the teacher of English has looked down on shop work. These mutual antipathies grow out of a vagueness with regard to the character of the mental processes connected with words and with manual activities. If we are ever to adjust the so-called academic subjects and the technical subjects, we must be perfectly clear that shop work and Latin are both forms of behavior. What is the nature of one form of behavior, what the nature of the other? These are questions which must be answered, in order to give to each subject its proper place and its proper relations.

Language as a form of behavior must be studied in connection with other forms of behavior and with reference to its development. We may, therefore, at the outset call attention to the fact that everyone, throughout his waking life, is intensely active. The muscles of the body are always tense. This tension of the muscles is due to the fact that the stream of sensory energy which goes in at the eyes and ears pours out into all the muscles of the body and maintains a general bodily tension or muscular tonus. When a special impression comes to the senses and arouses a particular set of muscles, a single definite contraction, as, for example, a contraction of the muscles of the arm, rises above the general bodily tension, and the arm moves through space. The ordinary observer is likely to overlook

the fact that the body was active before the arm moved. He will see the matter in a new light, however, if he thinks how much work is done all the time in holding up the body or the head during waking hours. If the muscles of the neck relax for a moment the head falls forward. The muscles of the body are likewise active all the time; and the particular movements of which we think when the term "activity" is ordinarily used are mere special cases of a general muscular tension.

Relation of Language to Emotions

Corresponding to the general tension of the muscles, there is a general excitement throughout the nervous system; and corresponding to this general excitement throughout the nervous system, there is a general tonus of mental life. We often speak of this as the emotional tone of consciousness. The man who starts out at the beginning of the day with buoyant spirits and head erect exemplifies the relation between bodily tonus and mental tonus.

The relation between mental life and bodily activity is also well illustrated by the infant. The infant's consciousness can best be described by saying that it is a mass of vague mental tensions. Some of these mental tensions reach a high level of intensity and stand out from the general body of vague, massive experiences. So it is also with the infant's behavior. The infant moves with all the parts of his body irregularly and diffusely. He exhibits infinite possibilities of behavior and unorganized tendencies of action. The business of experience is to develop out of these vague, general possibilities specific forms of reaction. With the development of specific bodily movements will come specific mental processes.

Among the earliest phases of indefinite reaction on the part of the infant are the reactions of the vocal muscles.

These vocal muscles, like the muscles of the arms and legs, contract at the beginning of life whenever there is a general excitement of the nervous system. Such excitement sometimes grows intense, as in the case of emotional reactions. The screaming infant is always a kicking and a striking infant. He does not scream for purposes of communication. Indeed, he does not have any appreciation of the world about him. His experience is all internal, personal, and emotional in type. Very shortly, however, certain forms of personal behavior begin to take on a unique value. The infant finds that some of his forms of behavior produce effects on those about him. Furthermore, he begins to note in those about him forms of activity which he can imitate. Certain forms of behavior come thus in a social group to have a value which they do not possess in individual experience. This fact can be illustrated by an example borrowed from adult life. When we are afraid we feel many internal contractions which we have not learned to control. On the other hand, we control our facial expression because we do not want to show to our fellows just how frightened we are. Facial expressions are easily observable, and we know it; hence our effort to suppress them. Our internal reactions and our private emotions we enjoy without interruption because no one can see them. So it is with the infant: certain of his external, visible reactions begin to stand forth in his experience as having a unique social value. He cultivates a social consciousness through a recognition of the effects of his acts.

Social Imitation influences Evolution of Behavior

Perhaps it will be well to study the growth of social consciousness in connection with forms of activity other than speech. To this end let us consider more in detail facial expressions. In the first place, the person who exhibits

the facial expression becomes aware of the fact that he is likely to induce imitation in others; and, in the second place, the person who sees the contraction of the facial muscles is aware of the fact that he is drawn into sympathy with one of his fellows. The person who exhibits the expression will therefore try to modify it if he does not wish to be imitated, or he may, on the other hand, try to exaggerate the expression if he wishes to be imitated. Conversely, the person who sees the expression will either try to suppress his own tendencies toward imitation or become absorbed in these tendencies. A simple example of social imitation is seen when a group of people imitate each other in yawning. The activity is in this case a very simple physiological reaction, and yet, because it is so easy to imitate, it takes on a strong social character.

If we study natural reactions we discover a whole series of graded steps of imitation and tendencies to take on social significance. For example, the angry man who shakes his fist in the face of his neighbor is very likely to induce an equally vigorous imitative response. Imitation here is more compelling than in the case of a yawn. A serious mood, with its accompanying expressions, will induce a like attitude in others. Here the external symptoms are many and complex. A spirit of optimism or pessimism is socially contagious because the person possessed of such a spirit is violently expressive. In all these cases, be it noted, we are dealing with social values which are more fundamental and, in a sense, more simple than speech.

Imitation reaches far beyond the muscular act itself. It not only brings the social group into harmonious action, but it also makes it possible for one individual to induce indirectly in his neighbor an inner state of mind. Thus, if by shaking one's fist in the face of his neighbor one can stir up an imitative act, he is likely also to communicate his anger to the person in whom he induces imitation.

Two consciousnesses are thus brought together through an external act which was originally attached only to the consciousness of one person.

Selection of Forms of Behavior for Social Communication

Once this possibility of communicating from mind to mind through external behavior becomes obvious in a social group, there is sure to be a rapid development of a general system of communications. The evolution of a system of communications will naturally emphasize that form of behavior which is at once easy to observe and easy to control. If there is some form of activity which impresses one's neighbor but which one cannot himself control, it is not likely that one will depend on this uncontrollable system of activity for purposes of social intercourse. A moment ago we referred to facial expressions as one of the avenues of social communication. Evidently, however, facial expression is not the best medium for influencing one's neighbor, because one is himself not aware of the way in which his facial muscles contract. In order to have the largest possible control of one's own acts, one must be able himself to observe his acts. We see, therefore, that the tendency in any social group will early be in the direction of emphasizing such activities as those of the hand rather than those of the face.

Gestures a Primitive Form of Language

One of the earlier forms of language is gesture language. When one makes a gesture he can see what he is doing, and he can also induce imitation on the part of the person with whom he is trying to communicate. Through social development the gesture, which was at first a purely

personal reaction, has passed into the sphere of elaborately meaningful acts.

For example, if the traveler on the plains wishes to express to a stranger whom he meets the fact that he is thirsty or hungry, he is able to do so readily by the use of gestures which point to his mouth and indicate that he wishes to have something to put into his mouth. The gesture in this case is undoubtedly accompanied by some degree of emotional excitement, but the gesture is more than an emotional expression — it is a means of communicating an idea. The gesture is a part of the total behavior which the individual would go through if he really wanted food. In this sense it requires no special training either to produce it or to understand it. Gestures have accordingly been called natural signs.

Conventionalized Gestures

Gestures come to be, in the course of repeated use, relatively much simpler than they were at the outset. Thus two individuals who have frequently communicated with each other can, by some familiar gesture which is a mere remnant of an earlier, more elaborate movement, arouse in each other's minds ideas which are definite and significant. This simplification of gestures appears in the study of deaf mutes and others who depend entirely upon gestures in communicating with each other. Gestures become simpler and simpler because the interpretation which the various members of the social group are able to give to them becomes more and more trained. Finally, the gesture is so far simplified that it is no longer a natural sign. It is significant in its simplified form merely because it starts a train of associations in a mind especially prepared by past experience to respond to the suggestion. At this stage the gesture is to be described as a convention; that is, several persons have come to use it for a common purpose long enough to

establish a like interpretation for each of the members of the trained group. A stranger who comes into the company is not able to use the gestures as do the members of the trained group, because in the stranger's mind there is no fixed relation between the simplified movement and its appropriate interpretation. The term "convention," as above used, is not to be understood to indicate that there has been any deliberate arrangement or agreement on the part of the members of the group; they simply came to use the gesture in this common way through their contact with each other. There is no conscious agreement to develop a system of signs; there is merely a natural development of the members of the group in the same direction until finally their expressions are naturally simplified.

Selection of the Vocal Cords as Instruments of Expression

Up to this time we have used examples of expressions and conventional activities which do not involve the vocal cords. This discussion of other forms of movement shows us how closely the evolution of vocal language has followed natural lines. We turn now to a brief consideration of the reasons why the vocal cords have come to occupy the position of preëminent importance which they hold in human life. We have in the vocal cords an organ of the highest degree of flexibility. The movements of the muscles which control the cords are more delicate than the movements of the hand or of most parts of the body. At the same time these movements produce, through the sense of hearing, a series of sensations which can be recognized by both the speaker and the auditor. There results thus, through the sense of hearing, the most advantageous control of the motor organs. Furthermore, the sensory experience which is produced by the vocal cords is not dependent upon external

conditions, except that there must be air through which the sound can be transmitted. As long as there is air enough for a human being to breathe, there will also be a medium for the transmission of sounds. In this respect the vocal cords are very much less dependent upon external conditions than are gestures. One cannot use gestures after dark, because the withdrawal of the light makes it impossible for the person addressed to see. On the other hand, the speaker can produce a noise even if he is in the dark. The external conditions do not limit him in producing noises, as they would limit him if he tried to communicate through the visual sense.

Finally, the vocal cords rather than the hands are selected as the instruments of social communication, because the hands are needed for other purposes. The hands in the course of human experience have come to be specialized as the organs for technical activities. We learn the arts and engage in them with the hands. We cannot spare the hands for purposes of social communication. Indeed, in many cases the chief importance of social communication is that it aids workers to coöperate with their hands, as in moving a heavy object. While the hands are too useful to be given over to communication, the vocal cords are useless as technical instruments. We cannot do anything in the physical world with our vocal cords. We cannot move objects about with the vocal muscles, and we cannot manipulate tools with them. The vocal organs are adapted to a single type of behavior, namely, social communication.

Evolution of Vocal Expressions

Once the vocal cords have been selected, and the general fact that a sound can be used as a medium of social communication has become obvious to a social group, there will appear a tendency similar to that which was pointed out in

connection with gestures. The sound will begin to take on meanings which are dependent more upon the training of the speaker and the auditor than upon the natural relations of the sound. For example, if we take one of the natural sounds produced by an animal and think of it as imitated by the human vocal cords, as when a child says "bowwow," there will undoubtedly be a natural relationship in the mind of both the speaker and the auditor between this particular sound and the animal which it represents. Gradually, however, the social group will be freed from the necessity of producing the complete natural sound in this case. A partial sound which grows out of the more elaborate natural sound will be entirely adequate to arouse the idea. The principle of association operates here, and the simplification of the expression goes on exactly as it did in the case of gestures. Furthermore, there are many cases in which there are no sounds produced by the objects to be designated. In such cases the naturalness of the sound will arise from the fact that a human being, in the presence of a certain object, tends to make a certain noise. It is often difficult to show why a particular noise is natural. In some cases the articulation is undoubtedly natural in the sense that one tends to make a loud noise in the presence of a large object, while one tends, on the other hand, to make a faint or shrill noise in the presence of small objects. One notes, for example, that his method of talking to a little child or a little animal is always different from his method of addressing an adult or a large animal. One tends to speak in a high, shrill tone when he speaks to a cat; whereas he never uses this pitch when speaking to a horse. The naturalness of the sound in this case is not dependent at all upon the sound which is produced by the animal itself. We discover here that behavior derives its naturalness from the human speaker rather than from the object named. Max Müller expressed this fact when he said that

if you strike a human being you will get a characteristic sound exactly as you do when you strike a bell. The critics of Max Müller's theory call this the "dingdong" theory of the development of language. They regarded the theory as fantastic, but there can be no doubt that Müller expressed a fundamental truth.

In the beginnings of language there were many situations in which vocal reactions were perfectly natural and, at the same time, distinctive because of the character of the situation in which the articulation was produced. If now a social group has repeatedly heard a sound produced in the presence of a certain object or situation, there naturally develops a tendency for the sound and the ideas to get themselves so definitely connected that whenever the object or situation is presented this particular sound will be produced. Conversely, whenever the sound is produced, the idea of that particular object or situation will arise in the mind. The question of the form in which such an association will develop is a problem to which we must return again. It is important to note, however, at this juncture, that what is associated with a partial sound is not merely a picture or image in the mind, but rather a whole attitude of reaction. When I utter the word "dog," or hear the sound which comes from uttering that word, the partial or verbal reaction expands instantly into the general bodily attitude appropriate to the experience of seeing a dog. If I am afraid of dogs, the essential part of the experience will be a feeling of violent contraction of my internal muscles and a desire to run. If I am fond of dogs, I shall have a reaching out of all my muscles and a feeling of satisfaction. There may be, and often is, no image in the mind at all. The word is part of a system of behavior rather than part of a series of pictures. The experiences attached to words thus include as important elements the feeling attitudes appropriate to the object.

Speech as Convention

In the course of development, sounds became more highly conventionalized than gestures. A newcomer in the social group which has many conventions has certain unique advantages and certain serious difficulties. He can acquire through imitation a whole system of expressions which the group developed very gradually, but he will have to take on many of the sounds without seeing anything natural in them. Thus the child who comes into a social group in possession of an English vocabulary will have little opportunity to exercise his inventive genius. He could doubtless make many natural sounds, but society has no time or patience to attend to his personal attempts. Society has its system, and the newcomer must learn the system. In the long run he will profit, for the system is more elaborate than anything he could invent, and it has subtle virtues which he does not always realize. His task is, however, a relatively artificial task. He must learn to control his vocal cords so that he can produce the great variety of sounds included in the language which he is trying to acquire, and he must learn most meanings as pure conventions. This latter is no simple task, and nature does not guide him. He will have to acquire meanings by any devices he can adopt, in order to bring himself into sympathetic contact with the ideas of his elders. Learning a language is, therefore, a very different process from helping to construct a language in a social group without established conventions.

Convention highly Advantageous

Critics of educational methods and results have often had occasion to emphasize the unnaturalness of words and the dangers that the intellectual life of the student encounters when he is introduced to words as the chief instruments of

his training. It may be well, therefore, at the very beginning of the study to point out the great advantages of an elaborate scheme of communication, even if that scheme is highly conventional. One thinks of the primitive savage who succeeded in communicating his emotions and a few of his simple concrete ideas to his fellows, and realizes that the moment this possibility of communication was developed, there grew up an intimate relationship between the members of the communicating group which made for social coöperation and social solidarity of the utmost importance. A tribe that had developed this means of communication was no longer made up of individuals relatively independent of each other. Rather, it was made up of a group closely bound together and able to coöperate with each other in the most efficient way. The larger and more powerful the social group became, the more important became the means of communication, the more dependent the individual found himself to be upon his social environment, and the more eager he was to cultivate the fullest possibility of social expression. Language came, therefore, to be an instrument of social union, and social union changed the character of individual effort and individual interest. It would be hard to exaggerate the importance of language among the forms of primitive human activity. The industrial arts developed slowly, but even these depended for their fullest usefulness upon the compactness of the social group. When the hunter and the arrow maker began to divide their functions in such a way that the hunter carried on one part of society's activities, and the arrow maker, as a specialist, played an entirely different part, it was language that held them both together in a single social organization. It was language which made it possible for them to exchange their products, and to reach an agreement with regard to the future policies which should set each one at work in his own particular line with the complete assurance that this type

of coöperation would be advantageous to himself and to his fellows. Man came to be, because of his use of language, an entirely different kind of a being from any of the animals. Indeed, he began to live a kind of life which had never been evolved in the animal kingdom; and his devotion to language was merely the expression of the fact that he depended upon this instrument of social life in a very high degree for the maintenance of the general conditions under which he carried on all of his activities. The pursuit of a line of thought such as this will show the student of human nature the value of social conventions as distinguished from naturalness of expression. The individual must give up something of his personal directness of reaction in order to become a part of the social whole, but the result is worth the cost.

Speech a Dominating System of Behavior

Little by little this one dominant mode of behavior began to draw into itself and associate with itself other forms of human activity. For example, primitive drawing originated in the beginning without any reference whatsoever to spoken language. Men drew pictures of objects, and through these pictures aroused in each other certain ideas. We have ample evidence that the earliest forms of picture-writing had no connection whatsoever with oral communication. In the course of time, however, just as gestures were simplified and gradually came to take on conventional meaning, so the pictures which are drawn by primitive men came to have conventional significance. There are evidences of this to-day in all of the conventional mythological figures which still survive as direct appeals to the visual imagination, in the totem pole of the Indian, and in the idol of the Oriental. These show that the pictures which men drew in the early stages of social life began to have a significance for the

group which they could not have had if there had not been a social group to use and interpret them. Certain of the pictures which primitive men drew were ultimately simplified and brought into the closest relation to words. If one goes to China to-day, he finds that every word has its corresponding picture. The Chinese picture-words undoubtedly originated at first as independent creations; but as soon as it was found that a picture could be related to a word, the picture lost its character as an appeal to the visual imagination and became a part of the abstract system of language. The possibility of using pictures as permanent means of expression and as a means of expression over long distances, both of space and time, gave them an influence on civilization which is in some respects superior to the influence exercised by oral expression. Oral expression, while less permanent and therefore less significant as a means of establishing records, was, however, the controlling system of expression and determined the ideas which should be associated with the written symbol. The written symbol had to express first a word, and through this word the related ideas. Incidentally, this subordination of drawing to oral expression is the strongest possible evidence that words are not psychologically dependent on visual images for their usefulness. Words are substitutes for pictures.

The foregoing psychological sketch of the origin of the written alphabet should be supplemented by a perusal of some of the more complete accounts of this evolution.[1]

[1] I. Taylor, History of the Alphabet (Charles Scribner's Sons, 1899); article "Paleography" in Encyclopædia Britannica (ninth edition, Vol. XVIII); C. H. Judd, Genetic Psychology for Teachers, chap. vii (D. Appleton and Company, 1903). See also at the beginning of each letter in the Century Dictionary a brief history of that letter.

Influence of Written Forms on Speech

After the domination of picture-writing by articulation had been completely effected, the reflex influence of written language on oral speech became everywhere apparent. Oral speech has to-day elements of conservatism and fixity which can be explained only by recognizing the fact that we not only speak our words but also write them. In uncivilized tribes the modifications of sounds went forward very rapidly because men had no permanent record of the sounds which constituted their language. Since the invention of printing — indeed, since the beginning of the use of writing — the permanent visual record has made it more and more difficult for dialects to break off from each other and for new signs and combinations to arise in oral speech. Other reflex influences of written speech have also shown themselves in the development of the history of language. The grammatical forms and the rhetorical principles which are operative in modern society are more governed to-day by written and printed language than by oral expression.

The reflex influences of written speech upon oral language are nowhere more apparent than in the practices of our schools. Here we find ourselves in a sphere where written language has been so much emphasized that it has come to be the dominant instrument of instruction. When we wish to give the child an idea in our American schools we usually do it through the printed page rather than through the spoken word. When one thinks of the number of printed pages that a child reads in the course of his education, one realizes how important this mode of instruction has come to be in our civilization. Probably a child in school reads more words in a year than he hears or speaks in all the class exercises which he attends. He becomes, therefore, as we sometimes say vaguely in our general discussions of school activities, eye-minded. He will begin to

establish preferences for writing as a means of expressing his own ideas as over against oral speech. As a result, we find that ordinary school training has limited very greatly the powers of oral expression in most children. Many a child and many an adult finds himself able to work out an idea if he is given a pencil and paper, while he is very far from fluent in oral speech.

Special Forms of Behavior connected with Written Language

The special psychology of the reading and writing processes includes, in addition to the foregoing discussion of the relation of writing to oral speech, a study of certain special forms of motor adjustments. We cannot enter into these details at this point. It is enough to call attention to the fact that there are special movements of the eyes which must be acquired by one who reads, and there are special movements of the hands and fingers which must be acquired by the child who is learning to write. Oral expression remains, however, the fundamental form of language expression throughout education, as shown by the fact that there is a tendency to articulate even when one reads and writes. Oral expression is, however, reduced to its lowest terms in the course of development. The ordinary observer may hardly be aware of the remnant of vocalization present when he reads or writes. Careful observation will show him that such movements are present, and scientific studies have furnished abundant evidence that we never lose entirely the tendency to articulate.

The problems of language instruction are thus multiplied as we recognize the various kinds of language activities which have arisen in modern society, and the complexities of behavior which appear in the forms of language consciousness cultivated in connection with reading and writing.

Reduction of Bodily Activities to a Minimum

Before we turn to the application of our studies of language, it is important that we should dwell upon the fact mentioned incidentally a moment ago. With the developments of meanings in words there has been a gradual reduction of the motor processes that are involved. This reduction of movements appears not only in the processes that accompany recognition of words, but also, and perhaps more completely, in the motor processes that are involved in the interpretation of words. The simplification and reduction of the interpreting reaction have gone so far in most cases that they illuded the earlier writers on psychology. Take such words as express anger, and study their effect on both speaker and listener. Such words arouse activities in the inner muscles of the body. I say to my neighbor that I will not tolerate so and so. We are both roused to a pitch of excitement that can be described only in terms of strong internal reaction. Other words are less exciting, but have this same relation to inner behavior; interpretation of all words depends upon these internal attitudes.

Words as Substitutes for Direct Experiences

When one realizes that words are thus interpreted through direct association with bodily reactions, a problem of language consciousness which has long confused teachers is at once cleared up. Through its association with reactions the word becomes a substitute for external impressions and makes it possible for the speaker and listener to have a whole train of vivid experiences without calling up any images or having any objects whatsoever in mind. This statement can be illustrated as follows: When I seize an object I get at first an impression of that thing; if the impression is disagreeable, I react by pushing it away.

The end of the whole process is the pushing away. Later, as I become acquainted with the thing, I push it away without examining it in detail; that is, without a complete impression of it. Finally, the merest suggestion that the thing is there will arouse the reaction. The reaction can now be detached from the thing and can be attached to some substitute for the thing. Thus the word "danger" sounded in my ear causes me to jump. The word "danger" is a substitute for an impression or an idea of a dangerous thing. The words "rough" and "smooth" arouse in me contrasting experiences without any necessity of first handling some rough or smooth thing. The words have in all these cases taken meanings to themselves; that is, they have taken on connection with interpreting forms of behavior.

It is not alone in the sphere of emotional interpretation that words become independent of the experiences from which they first derived their meaning. Take for purposes of illustration such words as "up" and "down." These words were at first interpreted to us in childhood by some-one who pointed upward or looked upward when he used the word "up." Sometimes the word was associated with the observation of a flight of stairs or a ladder. Ultimately all these experiences were condensed into a few faint tendencies to roll the eyes upward or downward, and the adult thus appreciates in an easy way, through a mere tendency to move, the meaning which the child had to learn through many experiences and much effort. Furthermore, the rolling upward of the eyes has, in the course of mental development, attached itself not only to tall things and high things but also to such matters as abstract values, as when we say that prices have gone up. Again, we say that a man's career is downward. Words thus come to have a value of their own without going back to things for their interpretation. Furthermore, words have a value for mental life which they could never have if they merely called up images.

Words Independent of Pictures in the Mind

Such a view of the psychology of words is in the most fundamental opposition to the view which teaches that words get their meanings by calling up pictures. That view thinks of a word as a clumsy device for reviving in the mind something more useful; namely, an image. That view is obviously disproved by all experience. It fails in the first place to explain that great host of words for which there could in the nature of the case be no images. Think of such a word as "appalling" or "inconvenient" and it will instantly be recognized that only in the most artificial way can such words be attached to pictures in the mind. But the doctrine of images fails at a second and, on the whole, much more crucial point. Words grew up at first as means of social intercourse, but once they had developed they proved to be of such value to individual thought that they have very largely taken the place of all the other means of individual thought. Even if images were the natural instruments of thought before words came, it is certain that now the greater part of the world's thinking is done with words. Images would be too clumsy for the mind which has learned the use of words. A moment's consideration of what has passed through the reader's consciousness during the last few moments will convince him that he does not stop to develop pictures. The fact is that words take on a character of their own. Contrasting words are immediately recognized as opposed. Related words are thought of as capable of combination. The psychological mechanism of interpretation can be understood in terms of tendencies toward reaction. When words contrast, one feels within himself opposing tendencies. When the word "appalling" strikes the ear, one feels his muscular system respond with a cringing, expectant shock. When one hears the word "magnificent" he feels a muscular expansion long before

he is able by any exercise of imagination to place before his mind a picture of a magnificent object.

A very instructive analysis of experiences connected with different words is given by Miss Rowland.[1] We may therefore quote at length from her work.

Miss Rowland's Analysis of Mental Processes aroused by Words

Miss Rowland presented to her subjects certain series of words such as the following: "entrance," "enter," "in," "inner"; "weight," "lift," "heavy," "under," and so on; and asked the subjects to observe carefully the moment at which they understood the meaning of the word and the mental processes which passed through their minds during the apprehension of this meaning. In describing the results Miss Rowland says that her subjects noted three stages in the development of meaning.

(1) A feeling of familiarity with the word, that she [the subject] would know presently what it meant (this stage of word meaning has been called "Implicit Apprehension" by Stout, in his discussion of this matter in his "Analytic Psychology"). (2) She then felt she would know how to use it, that is, the actual meaning came before (3) the images unrolled themselves in all their variety in the third stage. In other words, the images in the third stage seemed sometimes to stay the same for two words of allied meaning, whereas she felt at once there was a difference in their meaning or their use. Although visual images were always present when she attempted to define meaning, they seemed arbitrary and not to express its essence. She had, so far as she could discriminate, exactly the same visual image for drink and for water, that is, a person drinking water in both cases, yet the difference in meaning was evident and remained

[1] Eleanor H. Rowland, "The Psychological Experiences Connected with the Different Parts of Speech," Monograph Supplement No. 32, of the *Psychological Review*, January, 1907.

the same with all kinds of voluntary changes of the images. For this reason, she felt that the meaning came with the second stage. The sound of the word was familiar, and then she knew what it meant, that is, she had a peculiar feeling of knowing just what to do about it, whereas the images appropriate to the occasion (whether pictures, the word written, or what not), although present when she attended to them, seemed more or less arbitrary. Of course in a sense any idea or any feeling is an image, and one might contend that the feeling of knowing how to use words was a memory-image of former use or something of the sort. But it seems to the writer that such a broad use of the word image, applying it to any possible mental state, simply vitiates its own particular significance. When image is used in this discussion it will refer to reproduced sensations whether of sight, hearing, touch, or any other; whereas feelings, attitude of like or dislike, tensions, etc., will be designated as such. The subject admitted that no definition could be given of the word without some visual or auditory images, some specialized associations. But she also insisted she felt what it meant before she could define it, even to herself, and that if she waited for images to elucidate the feeling, there was no determining where to stop.

On page 5 Miss Rowland defines somewhat more fully, in the following statement, what is meant by one of the stages.

EMPHASIS ON REACTIONS

The feeling of word meaning is apparently composed of knowing how to react on it to some extent. This reaction is at its lowest stage when the ability to react is solely to write or speak it, or even to give some approximate imitation of it in tone or articulation. This knowledge of reaction varies in complexity. It may be only slight knowledge of the general nature of reaction, that is, it is an imperative to do something, although just what is not recognized. Or it may be a rich complex of varied and discriminating associations. This necessary reaction means physiologically that the sound of the word has brought a train of associations with it and in going over into its centrifugal discharges, the number and extent of open channels

varies largely. If nothing is known of the meaning of the word, but it is articulated by the human voice, the feeling of familiarity or vague consciousness of meaning (when in truth it has no ulterior significance) is merely the general feeling of the organism which accompanies the opening of the channels appropriate to reproducing the word by speech or writing. If the word was too complicated to be reproduced accurately, simply an approximate reproduction would be sufficient. There need be no actual felt tendency to reproduce, indeed no strain or sensation of any kind. But the very sensory stimulus of the sound must have some motor discharge before it can become a conscious state. The combined discharge of the associated auditory or written images which may be with it (more or less distinctly) gives a certain balance or set, to consciousness; that balance gives rise to its own peculiar feeling; and that feeling is the skeleton of its so-called meaning. If on receiving the stimulus there was not even a reactive tendency to reproduce the word, the last vestige of its meaning as a word would be gone.

Miss Rowland's analysis of the different parts of speech shows that while the imagery for different words may be the same, the particular significance of the different parts of speech is brought out in the accessory feelings of reaction which characterize each. Without attempting to report in full her findings with regard to all of the different kinds of words, we may repeat her statement with regard to adjectives. Adjectives differ from nouns, in that the former are more likely to call up visual images. Even if one accepts the general theory, that a noun gets its full meaning through the association of the word with images, the adjective has a character which is to be defined as follows:

SPECIAL MENTAL PROCESSES CONNECTED WITH ADJECTIVES

Adjectives seem to be more intimate, more personal words than any yet given. Several phrases were used by the subject in explanation such as "broader feeling than noun," "seems to spread over the whole of me," and it was noticeable that

almost invariably some feeling-tone was connected with the adjective. Although the adjectives were thought of as applying to something else, the meaning was felt in terms of their effect on the person. Thus, in all the phrases "sharp wind," "sharp knife," "sharp rebuke," "sharp pain," the abiding sense of sharp, although applied to different objects, meant a subjective cringe. The likeness of all these various nouns was solely in the fact that they produced the same kind of a shiver. The adjective state of mind is composed of a definite qualitative content. It involves no purposive action, no feeling of the self as agent and acting toward an end or of anything else doing so. It is concerned with subjective reaction regardless of what it acts on or any end to be accomplished.

Sentences as Psychological Units

Finally, one quotation may be made from Miss Rowland's statement of the way in which words are used in sentences.

The tendency in all higher word combinations is to temporarily deprive the words of all associations that do not contribute to the meaning of a sentence as a whole. The span of attention is limited, and if we had as complete a reaction as I have described for each word in a sentence, we should be lost in the meaning of the parts before we could combine them in a whole. We do not give equal value to the different parts of a sentence, but we dwell on the more important words, while those of lesser interest serve, not as independent words, but simply as parts of the associative cluster that makes up the meanings of the others.

The meaning of a word in a sentence varies, and demands strictly a change in word-form to express this variation, as one or another of its associations or motor reactions is sacrificed for the more concise meaning of the sentence.

The tendency of language development for practical and scientific purposes is all in the direction of economizing the separate word-reactions, for the sake of the meaning of the sentences as wholes. But in these cases, while we get more meaning from the sentence than we could from any separate

word, we are not getting as wide an individual meaning from any one word as if we heard it alone. The words limit each other, and by their very definiteness cut off the extent of their individual significance.

SUGGESTIONS OF A PSYCHOLOGY OF A LITERARY STYLE

The highest literary style consists of a nice adjustment of values, where the words mean all that they possibly can, without confusing the combined meaning of them all. On the other hand, scientific style of expression differs, in that the separate words are allowed only as much independent significance as is necessary for the sentence to have a meaning. This prevents any doubleness of interpretation, and more can be crowded into a single given space. In general, a phrase may become a kind of elongated word, and may have meanings in every way analogous to word-units as we have studied them. When these phrase-experiences are described, however, the analysis must fall into the same terms as we have used for the word-experiences.

World of Words

The world of thought is enormously expanded by the creation and use of words. It is little wonder that man for long ages thought of himself as absolutely distinct from the rest of the animal kingdom. Man lives in a world of words; the animals live in a world of things and memories of things. To those who can use words so as to influence the rest of us we give society's great rewards. To the combinations of ideas which have been worked out in words, we owe changes that have later been wrought out in things. In short, our civilization rests on words more than on things themselves, for our civilization differs from primitive, uncouth conditions chiefly because the economical methods of thought and action made possible by words have transformed our relation to the world and put at man's disposal forces which could not have been discovered or mastered without the higher modes of abstract thought.

CHAPTER VIII

THE ENGLISH PROBLEM

Instruction in the Vernacular Late

The problem of finding the true place of English in the school course of study can be understood only by recalling the historical fact that in the beginning no one thought of the vernacular as a suitable subject for school training. It was assumed, and is, indeed, assumed to-day by many people that one can acquire his native tongue without any special education. Foreign languages, it was recognized from the beginning, must be taught by a teacher, and the subject matter which enters into science and history evidently requires to be taught before it can be mastered; but the use of common words and the formation of common sentences are assumed as a part of the informal training of the child through his home and through his everyday environment. We read in the history of education, therefore, how the vernacular was brought into the school by the special plea of Martin Luther and his successors as an innovation in the educational system. Up to the time of the Reformation the languages taught had all of them been the remote and unusual languages.

Unfamiliar Aspects of Language first emphasized

Coming down to the modern period we find something analogous to the movement which was inaugurated at the time of the Reformation. We find that the high school of a generation ago assumed that the student would get English

incidentally as a part of the rest of his work. Up to that time the lower schools had indeed recognized the importance of teaching reading. Like a foreign language, reading requires acquaintance with a set of symbols which do not confront the child in his ordinary home life or in his play on the street. The early New England school, founded explicitly as a reading school, was therefore a very natural concession to the demands of society for the special training of children; but the New England reading school was not a place where the child was trained in oral language. So also the high school of a generation ago was absorbed in a kind of training which emphasized very little the common use of the mother tongue. The high school put into the hands of its students many books which they were required to use, but there was little or no pretense at training children in modes of common speech or in the use of common forms of conversation. The only phase of the vernacular which was taught in these schools was formal grammar, that is, the structure of language. The upper grades of the elementary school usually went over grammar in great detail, but in some cases the course commenced in the high school. Grammar, as the science of language, was taught in imitation of the methods prevalent in teaching the classics, on the assumption that the student would know the words and sentences of the language before he began to take up the rules of parsing and grammatical agreement.[1] Still later, when some training in the use of words was brought into the school as a substitute for pure grammar, it was found that written composition received the emphasis. It is even to-day assumed that the ordinary child can talk, but it is conceded that he cannot write well; hence the school must take his writing in hand. The spirit of all these efforts to bring the vernacular into the course of study is the same.

[1] F. A. Barbour, The Teaching of English Grammar: History and Method. Ginn and Company, 1902.

They all begin with the remote, the unusual, and the abstract. It is very hard to organize any plan of school work which will emphasize the common use of the vernacular.

ENGLISH COMMONLY TREATED AS A SPECIAL SUBJECT

At the present time we are in the curious situation of desiring to recognize the vernacular to the fullest possible extent, and yet we are unable to see that the vernacular means expression whenever and wherever it appears. Every one realizes that students are defective in their oral expressions even in their English recitations. Students, after years of schooling, do not know how to carry on for any length of time a coherent and continued discussion — evidence enough that the schools and the English department have not mastered their problem of training children in coherent common use of the vernacular. It is assumed that children will be able to get on in history and physics and mathematics because the vernacular is there the common medium of expression. The fact is that half the difficulty of children in these subject-matter courses arises from their inability to understand English sentences. The English department and the school in general continue to assume that the business of the English department is to deal only with those unusual phases of the vernacular which are not of daily significance. Therefore we find the English classes devoting themselves to composition or literary studies of a type which has very little relation to practical life and little relation to the rest of the work of the school.

In opposition to the assumption that English is a special subject the effort is sometimes made to call attention to the desirability of a constant supervision of the use of the vernacular throughout the day and throughout all of the activities of the students. This plea gets scanty hearing, because our educational system at the present time is divided into

a number of special interests, and there seems to be no one now responsible for the general training of students except, possibly, administrative officers. One reads with a good deal of interest the plea of the English teacher that he is quite unable to master the situation because he has no authority over other members of the high-school faculty;[1] that only the principal can bring about the reforms which are now needed in English training in the schools. This means, from the side of the English teachers, that they are unable for some reason to present with compelling force arguments in favor of a general cultivation of the mother tongue.

Members of other departments undoubtedly look upon the work of the English department as a special and closely delimited phase of training. Teachers of English in the high schools are thought of as a group of people who have been trained in a specialty. That specialty is literary form. The ordinary English teacher knows the classics of our language and is interested in bringing to the attention of students the virtues of these English classics. He would encourage the student to imitate these classics much as the teacher of Latin used to try to induce his students to imitate Cicero. For the most part English teachers, trained as literary critics, are wholly unaware of the fact that their place on the program of the high school of to-day depends upon something more fundamental than interest in literary form. When, therefore, the English teacher gives a course which is virtually a course in the history of literary form coupled with a few technical exercises which aim to cultivate literary form in his students, he widens the chasm between himself and all of the other departments, since the other departments are interested in the vernacular for

[1] James F. Hosic, "The Coöperation of All Departments in the Teaching of English Composition," *Proceedings of the National Education Association*, 1913, p. 478. See also *School Review*, 1913, p. 598.

wholly different reasons. The man who teaches science cannot be made excessively enthusiastic about literary form and its history. His use of English is for an entirely different reason. He may not know how to tell the English department just what he wants. Indeed, he is often so disgusted with the work which is now done in English that he will not take pains even to consider how the English department may be improved.[1]

Grave Dangers of Specialization

There is a lack of unity of purpose and lack of sympathy in the handling of expression in schools which grows out of the fact that both the man of science and the teacher of English are specialists. Illustration after illustration of this highly specialized interest can be found in the current literature which deals with the teaching of English in the high school. There is a conspicuous illustration of this in Mr. Percival Chubb's book, "The Teaching of English."[2] The book sets forth in vigorous terms the desirability of more training in English in the high school and the elementary school. In his effort to define the general purpose of English during the adolescent period, Mr. Chubb says on

[1] An anonymous writer in a communication published in *Science*, September 4, 1914 (*N.S.*, Vol. XL), pp. 344–346, gives an excellent example of the temper of the teacher of science toward rhetoric. The communication is an answer to a review published in the February (1914) issue of *Modern Language Notes* of "Representative Essays in Modern Thought," by Steeves and Ristine. The book under discussion is written in the effort to stimulate the study of other forms of literature than the *belles lettres* commonly taken up in English courses. The conclusion of the discussion is given in the following sentence: "And yet, if rhetoric instructors do not awake, some time or other scientists, engineers, and lawyers will somehow face the problem of themselves instilling the principles of unity and coherence into their promising students." The whole communication is a most urgent plea for the study of themes of a scientific and practical type.

[2] Published by The Macmillan Company, 1909.

page 239 that one of the main divisions of literature which should receive attention in the secondary school is that which deals with vocational subjects. He reviews enthusiastically the position taken by G. Stanley Hall, that the vast majority of high-school graduates should get social training through the vernacular. They should be given that kind of reading and opportunity for expression which will prepare them for social and personal life in the vocations. One reads this part of the book with great interest, and assumes that now, at least, we have reached the point where the vocations are to receive adequate attention from the English teachers. He goes on through the book, and, to his astonishment, finds that all of the references to books that are actually to be used are of the conventional literary type. There is not mentioned in the whole volume a single book of a strictly technical type. The specialist in English literature has once more shown that he does not have any idea of his duty to the vernacular in general. One is reminded of the story told by the high-school principal, who, after urging his English teachers to put in some vocational reading, encountered a teacher glowing with enthusiasm because of her success in complying with his suggestion. She was reading "Silas Marner" with her class, and since Silas was a weaver, she was introducing vocational ideas at the same time that she satisfied the college-entrance requirements.

English Program should be reduced

Probably the whole fraternity of teachers of English would ask, if they were confronted by such a remark as the foregoing, "What is expected? Are the high schools to devote themselves to the reading of books on mechanics? Is the English department failing to do its duty when it devotes itself to its proper task of training students to appreciate and produce higher things?" The argument

would undoubtedly be presented that it is the business of the English department to see to it that the student carries away an appreciation of those books which are not discussed in the other classes. Undoubtedly there is some justification for this specialized kind of training; but the point which is to be made is that the school program of the present day gives to English an amount of time which is entirely at variance with the assumption that English is a specialized subject. No high-school faculty which votes for four years of English to be required of every student would vote that amount of time if the statement could be explicitly put before them that these courses are all to be devoted to the development of literary form. This amount of time is voted because it is assumed that English somehow is to be regarded as a fundamental, underlying subject, of more significance in the life of students than any other single subject. The deplorable fact is that after all of this time has been given to English teachers, they do not realize that it is their duty to distribute it in some fashion which will comport with the assumption on which the time was given. Perhaps two courses in our present-day high-school course of study could be justified as requirements if English continues to be what it is now, namely, training in literary form; but certainly there ought not to be four courses required of students, nor ought there to be three, and there may be some question whether it will not be wiser to make even the second English course elective.

The Unsolved Problem of teaching Reading

There is another aspect of this matter which ought, perhaps, to be discussed in reënforcing the general criticism of English work contained in the preceding paragraph. It is assumed that high-school students know how to get the meaning out of paragraphs which they read; that is, it is

assumed that the work of elementary education has been satisfactorily completed, and that elementary reading has prepared students for all their later work. The fact is, that the ordinary student does not know how to read economically. He is very clumsy in his methods of getting the meaning from his textbook in history or his textbook in science. This deficiency of the high-school student is of importance both to the special teacher, who is training the student in history and science, and also to the English teacher, who is training him in reading. Both teachers, however, overlook the necessity of training in reading and in interpretation of what is read. We have not yet learned the lesson that the commonplace activities are, after all, the most important activities to be trained. Why we should assume that the child knows how to take up and study a book economically when no one has ever helped him to see the importance of economy in his reading, is difficult for the student of education who is not a specialist in English to understand. To the student of education who sees history and science and English literature all as phases of the general effort to train the mental processes of children, the fundamental and general requirement, that mental processes be trained so that mental work can be done in an economical way, is more significant for the child's training than is the demand for any particular type of training. This general demand, that the student know how to study, is neglected by too many teachers because they are interested in some particular subject matter. The psychologist, on the other hand, who insists upon the recognition of the general fundamental needs of all students, discovers that there is no one especially charged in the school with the duty of training children how to use books.

The critical student of education feels justified in charging this deficiency most heavily against the teachers of English because they have so much time given them and

because they have so little content requiring to be taken up. But the English teachers, like the other special teachers, are contributing what they can to the development of uneconomical habits of the use of books. No one who has seen an English class working with the question-and-answer method on a literary masterpiece, such as "Ivanhoe" or "Silas Marner," can fail to recognize the fact that asking questions about a book, and asking questions in such detail that the student's attention is distracted from the general story to the minutiæ of the matter on successive pages, is the worst possible preparation for the use of books. English teachers are absorbed in subject matter just as are the teachers in other departments. They are so much absorbed in subject matter that they do not realize that they are impeding in many cases the student's mental development in the use of books. It would be very much better to allow a student to read the whole of "Ivanhoe" through at four or five sittings than to spread the study of this book over half a year. Requiring the student to digest a story in small fragments and to answer the most minute questions with regard to each fragment is to cultivate a habit of mind with regard to books which is utterly disastrous for later life. The student gets an impression that a story of this sort is a Herculean intellectual problem. He will never be stimulated to take up a book of this sort in leisure hours in his later life if he is impressed with the immensity of the undertaking.

The Sad State of English Composition

What the student of education finds to criticize in the class in literature fades into insignificance when he follows the English teacher into that burying ground of human interests, the class in composition. Where shall the bewildered observer begin his psychological analysis of these so-called exercises? Do they make for economy of expression?

When a student is given one of the usual subjects presented to the composition class, he is fortunate if he has ideas that would cover half a page. He is encouraged to write these few ideas in a form which will cover three or four pages. Indeed, the requirement commonly set down is one which states the amount required rather than the quality. The student is told to write two pages on a given subject. Furthermore, the subject is frankly acknowledged to be one which is of no practical value. He writes on it in the English class because it is of no value and therefore can properly be made a subject of discussion from the point of view of its style rather than from the point of view of its usefulness to anybody who comes in contact with it. A student who has thus been trained in the making of useless paragraphs is likely to look on paragraphs in general as belonging to the same type. He will come to think of the writer of books as a person who has set himself a task of covering so and so many pages with words, and his whole notion of literature will be perverted by his own frantic efforts to fulfill a certain requirement on a subject in which he is not interested and on which he has nothing to say. The written page comes to be for him a sham battlefield, different from the industries or practical activities of life, where practical efforts are made in the spirit of serious accomplishment.

Lounsbury on English Composition

Perhaps one would be less bold in such estimates of composition if he did not have the support of that veteran teacher of English, Professor Lounsbury. In commenting on required composition, even in college, he writes: [1]

I am by no means disposed to go so far as the historian of New England, John Gorham Palfrey, who, as I have been told,

[1] Thomas R. Lounsbury, "Compulsory Composition in Colleges," *Harper's Magazine*, November, 1911, Vol. CXXIII, pp. 866–880.

was wont to express the desire that an act of Congress should be passed forbidding on pain of death anyone under twenty-one years of age to write a sentence. Excess in one direction can not be remedied by excess in the opposite. Still, none the less am I thoroughly convinced that altogether undue importance is attached to exercises in English composition, especially compulsory exercises; that the benefits to be derived from the general practice in schools is vastly overrated; that the criticism of themes, even when it is fully competent, is in the majority of cases of little value to the recipient; that in a large number of instances the criticism is and must ever be more or less incompetent; and that when the corrections which are made are made inefficiently and unintelligently, as is too often the case, the results are distinctly more harmful than helpful. (P. 869.)

Professor Lounsbury would have us abandon the whole farce, and recognize that the ordinary student can never produce literature and never ought to be perverted in his tastes by having to contemplate his own productions. The student ought to be introduced in a large and liberal way to some of the vital productions in his mother tongue, and he ought to have these set before him not as subjects for minute scrutiny and clumsy imitation but rather as examples of documents which have molded history and guided the thinking of men in politics and religion and in the organization of social institutions.

Dangers of Extreme Formalism

The time will certainly come when the historian of education will look back upon the present period of high-school composition and high-school dissection of literature as one of the most formal periods in education. It will be said of us that we gave up all of the advantages of a compact and consecutive course in the classics before we succeeded in bringing into the high-school curriculum anything that gives the continuity and definiteness of

training that these older courses provided. It will be said that we wasted the time of our students on a type of literary pedantry which did not justify itself even to the teachers of the subject itself. In evidence of this the writings of the teachers of English will be quoted. There is no group of teachers who more frankly acknowledge the complete failure [1] of the work which they are doing. They disagree with each other at every point with regard to the content and methodology of their work. They frankly report the results of their own tests to show that high-school students and college students alike fail to meet even the most elementary standards of achievement which are set up. Yet they insist that they must have the time which they now occupy, and indeed in some quarters they clamor for more time and attention. They complain about the number of hours that they have to spend in correcting compositions, and ask for more assistance.[2] They point out the fact that their present mode of teaching wears out teachers so rapidly that the average professional life of an English teacher is less than that of members of other departments.[3] In the midst of acknowledged failure and chaos they keep insisting that what they are doing is of the highest importance. They scoff at the courses in manual training and vocational training. They criticize the sciences as uncouth and unæsthetic. They charge the classics with formalism, and they regard mathematics as abstract and uninspiring.

[1] Twenty Years of School and College English. Published in Cambridge, 1896. F. N. Scott, "College Entrance Requirements in English," *School Review*, 1901, Vol. IX, pp. 365–378.

[2] "Requirements for Admission to the Freshman English Course," *Bulletin No. 13*, University of Wisconsin, 1914. *English Journal*, Vol. II, 1913, p. 398. Reports of committees and individuals on "Amelioration of Conditions," published in the *Proceedings of the National Education Association*, 1912, pp. 747–765.

[3] James F. Hosic, "The Advance Movement of Teaching of English," *Proceedings of the National Education Association*, 1913, p. 91.

CHAPTER IX

THE PSYCHOLOGY OF ENGLISH COURSES

It is the purpose of this chapter to discuss the mental processes which are cultivated in the English courses ordinarily administered in high schools. We shall follow this discussion by a study of the methods proposed for teaching foreign languages, and then come back to the problem of the relation of verbal consciousness to other types of mental activity.

CARPENTER ON THE PURPOSE OF ENGLISH TEACHING

In his statement of the present-day purpose of the English course, Professor Carpenter[1] contrasts our period with two earlier movements. First there was a period in which grammatical correctness was the aim. This was the period of Lindley Murray and Noah Webster, and covers the middle half of the nineteenth century. Then came from 1874 on, after the Harvard entrance examination in English was established, a period of emphasis on rhetorical study. "The third ideal, that now rapidly coming into prominence, is that of familiarity with, and appreciation of, English literature." Accepting Professor Carpenter's classification, we may omit from discussion grammar, except in so far as it survives in the rhetorics; we must consider the aims of rhetoric, since the rhetoric period is not yet passed, and we must take up the newer movement, which is devoted to literary appreciation.

[1] G. R. Carpenter, F. B. Baker, and F. N. Scott, The Teaching of English in the Elementary and the Secondary Schools, p. 189. Longmans, Green, & Co., 1913.

COMPARISON OF TEXTBOOKS ON RHETORIC

Within rhetoric itself the most conspicuous change is from a long statement of rules and principles to a very great abbreviation of rules and much attention to practice, especially written practice. Exercises, then, are an important part of any book on composition.[1] Indeed, the modern textbook often bears in its title the frank emphasis upon exercises. "English Composition," "Essentials of Exposition and Argument," "Practical Training in English," are among the familiar titles of the modern rhetorics.

Let us contrast the chapters of one of the newer rhetorics with the chapter headings of one of the older books. The modern book[2] treats, in successive chapters, The Sentence; Forms of Discourse, Narration; Forms of Discourse, Description; Letter Writing; Forms of Discourse, Exposition; Forms of Discourse, Argumentation; Figures of Speech; Verse Forms. The older book[3] has such chapters as the following: Style; Simplicity; Precision; Purity; Perspicuity in Sentences; Perspicuity in General; Figures of Speech; Figures of Relativity arising from the Perception of Resemblance; Figures of Gradation; Figures of Emphasis; Part III, Harmony in Style (including seven chapters); Part V, The Emotions (including chapters on The Beautiful, The Fantastic, etc.); Part VI, The General Departments of Literature (including Description, Narration, etc.).

This contrast shows how greatly rhetoric has been simplified. The older book was, to be sure, used in college more frequently than in high school, but it is typical of the painstaking effort of the rhetoricians of that date to be inclusive. The present-day rhetorician aims to stimulate

[1] W. F. Webster, English for Secondary Schools, p. iii. Houghton Mifflin Company, 1912.

[2] Ibid.

[3] De Mille, Elements of Rhetoric, 1878.

composition, and reduces his statement of principles to the smallest possible compass.

Turning now to the remnant of rhetoric which has survived, we are impressed at once with the frequent excursions which every author makes into psychology. The student is called upon to consider how language portrays ideas.

> Just as the artist has to avoid certain combinations of colors because they offend the eye, so any person, using language to communicate his ideas, must obey the rules of language if he wishes to please people by what he says. . . . A sentence has been defined as a group of words expressing a complete thought. . . . Sentences may be defective because they are not the full expression of one complete thought.[1]

Rhetoric a Formal Study

These examples show clearly that one of the major functions of rhetoric is to turn the student's thought to his mental processes as distinguished from the content about which these processes are concerned. Rhetoric is a science of the forms of thinking and expression. The older rhetoricians were fully aware of the relation of their subject to logic. Indeed, the old-fashioned course was often a course which explicitly combined logic and rhetoric. The high-school student has difficulty with this formal science because he is not mature enough to distinguish between his thought-process and the content of his thought. The teacher asks him to write on his vacation, and he does so. He then discovers that the teacher does not care at all about the vacation or anything pertaining to it. The teacher is interested rather in the way one thinks and the way one expresses himself. Very often the student is still further confused by the contrast between thought and expression. He finds that one may have an idea, but not be able to get it into

[1] W. F. Webster, op. cit., pp. 1, 2, 8.

acceptable form for communication. He now has three things to consider: ideas, how one has ideas and arranges them, and finally how one expresses ideas.

The complexity of the situation which thus faces the student is hardly understood by adults. Most mature minds have faced in some form or other the distinction between content of thought and the forms of thought. But the high-school student does not readily grasp this distinction and is seldom interested in the introspective facts. Just as soon as an adult begins to talk about forms of thought to a high-school student who is absorbed in some real content and quite unconcerned about his own mind, there is sure to develop an educational situation which is confused and unproductive. The student is absorbed in things and in people and their doings. He is not likely to look into his mind for forms of thought. On the other hand, a teacher who becomes absorbed in noting how his students think and express themselves will find the problem of form so interesting that he will forget all about the subject matter. He will become an observer of thought-processes and modes of expression and will be unable to understand why his students are not interested, as he is, in the forms of experience. The breach between student and teacher may become infinite.

There is one common ground on which teacher and student may meet and often do meet; that is, in a study of the history and structure of language. So the study of an elementary form of science of language comes to be in many cases the real object of attention in the rhetoric class. The history of particular words is an interesting chapter in this kind of rhetoric. The structure of the sentence, the principles of agreement and subordination, become the absorbing topics. Such a study is not without value. Students learn something about language and its history, and they will doubtless be aided in the long run by such knowledge in controlling their own expression.

There is another sense in which rhetorical knowledge of the type which we have been discussing is formal. A student may know about words and sentences and yet not apply his knowledge in his own performances. The psychology of application of knowledge turns up again here as it did in the case of mathematics. We shall have to let the problem thus suggested wait, noting that here, as in other courses, the problem of applications presents itself as one of the most important problems in education.

The Four Fundamental Forms of Discourse

There is one series of topics which appears in all of the rhetorics, namely, the four fundamental forms of discourse: narration, description, exposition, and argument. Some writers do not attempt to deal with all; some use the classification as the basis of all their treatment; while others touch upon it only lightly, devoting the major part of their time and attention to details rather than to these more general distinctions.

The four fundamental forms of discourse may be treated as representing four different mental attitudes. They can also be discussed from the side of content when the emphasis is laid on the fact that they differ in the type of subject matter which they present. Let us select a number of statements illustrating the fact that the classification of forms of discourse describes mental attitudes. Thus in discussing narration one author states:

> The mind does not think in single words, complete enough so that they represent a single idea. . . . Such a group of words is like a picture thrown upon a screen. . . . And just as a series of single pictures tells a story at the moving picture show, so a series of groups of words tells a story in man's everyday life.[1]

[1] W. F. Webster, English for Secondary Schools, p. 63.

Later he defines description in these terms:

In the preceding chapter it has been pointed out that the sequence of language is well adapted to detail the sequence of action in a narrative. For the purpose of presenting a picture, language has serious drawbacks; the picture has to be shown in pieces. . . . Each [phrase] introduces a new element into the picture; and then, from these phrases the reader must construct the real picture (p. 105). Exposition treats of abstract ideas, either general terms like horse, man, tree; or propositions (p. 202).

On the other hand, the attempt is often made to define each of the forms of discourse from the point of view of content. "All composition may be arranged in two great groups. The first group includes composition that deals with real things and incidents; the second group includes compositions that deal with thoughts and ideas" (p. 55).

The quotations which have been given show how easy it is to take first the psychological attitude and then to turn directly to the objective attitude. That students are confused by these different points of view is hardly to be wondered at when their immaturity and lack of training in introspective analysis is kept in mind. Rhetoric of the psychological type is very abstract and vague to the ordinary student. Rhetoric based on the effort to classify subject matter is likely to get the student into difficulty, because subject matter refuses to follow the lines laid down in the classification. The classification is essentially logical and psychological.

Enough has been said in the foregoing analysis of textbooks to bring out clearly three general facts. First, the older textbooks dealt frankly with the forms of experience and expression; the later books attempt to make rhetoric concrete and thus often confuse with considerations about subject matter a study which is essentially a formal subject. Second, the study of formal aspects of expression is

an abstract study, and high-school students can only with difficulty neglect that in which they are most interested, namely, subject matter, to concentrate attention on form. Finally, present-day rhetoric is not complete or successful even on its own chosen grounds. It does not deal adequately with subject-matter problems because it is divorced in its organization from subject-matter courses.

Oral Composition

In the general books on teaching English in high schools a problem is discussed which is omitted from most texts; namely, the problem of oral composition. When one goes to the classes in English as actually conducted, one finds very little oral composition. This is, perhaps, one of the greatest weaknesses of American schools. The student in an American class seldom says more than three sentences, and often he says only a word or two. Teachers do not seem to realize the value of continuous discourse, and the rhetoric books, while they talk about argument, very seldom give any serious attention to oral argumentation. Oral expression is, in its psychological elements and organization, very different from written composition. Oral composition must be rapid. Writing may be very deliberate. Oral composition is less likely to be influenced by the models which the student has read. When one is writing, the length of the sentence, the character of the words used, and other details of expression, such as the rhythm of phrases, will all be determined by the qualities of writing activities as much as by anything relating to the vocal activities. It is a mistake to assume that oral and written composition are the same. The lack of regard for oral expression has been commented on before as an evidence that the English teacher does not view his task broadly enough.

Verse used in Composition

A word may be added with regard to verse as a form of composition. Objection to the use of verse often arises from the fact that the mind of the student is likely to associate verse with sentiment, and the temptation to indulge in trivial sentimentality is overpowering when composition is undertaken in this form. On the other hand, there is no type of composition which so definitely checks and controls the form of the student's work as versification. If some of the narrative poems are adopted as models so as to overcome the objection of sentimentality, it is possible to use verse-making as a very compelling type of formal training. Any work which checks itself is excellent material to use in training an immature student, because the rules are automatically kept before the student's mind by the product itself.

One cannot leave the topic of rhetoric and the forms of expression without commenting once more on the dangers of formal work in the English class. Formal training is not damaging to the student if it is a part of a more general system of education in which form is ultimately filled with productive content. Training in form can always justify itself as a necessary part of the total equipment of the student. The danger arises when form replaces complete training. When form becomes an end, then the system of education has abandoned its legitimate function, which is to develop the individual's experience. Form which is magnified above content is empty and a burden. Many a rhetoric class exhibits the sad spectacle of a teacher absorbed in form and quite unconscious of his weakness. The students in such a class do not know what the difficulty is, but they realize that the subject is utterly lacking in inspiration and they are the more confused because they do not see what is the purpose of the work.

Psychological Observations in a Rhetoric Class

Observations made in a rhetoric class add three general statements to those which have been derived from a study of the texts. In the first place, the questions asked are usually of such a character that any one of several different answers will satisfy the demand. What criticism is to be offered of the paragraph is a typical question. The students now begin to cast about for the teacher's probable idea in asking the question. Very often it is a lottery, and the student knows it and is prepared to take two or three trials if the teacher's patience holds out.

In the second place, the number of different kinds of judgment which a student is called upon to pass is much greater than in most subjects. In mathematics the judgments and comparisons are fairly uniform in type and the different varieties are limited in number. Not so in English. The following types were enumerated in one period. Whether the author was recording a fact or a fictitious idea was investigated, and the students passed judgments on the evidences submitted. Again, the relative importance of the fact stated was discussed. This led to the general discussion of the importance of the fact for the narrative and the importance of the fact for the real outcome. The students were asked to judge of the appropriateness of the narrative with a view to arousing the desired ideas in the audience. This called for a discussion of the mental processes of the audience. What kind of emotions do people have in such cases? Is the narrative detailed enough? Is the order of events such as to produce the most vivid effect? In this connection a little attention was given to the individual words employed, and very shortly the discussion drifted off into a study of the history and form of words. The students were then brought back to a discussion of the way in which the passages illustrated rhetorical principles studied

earlier in the course. This led to a review and application of general principles regarding form. Finally, the students were asked to compare this passage with others with reference to the form and with reference to the content.

Such an array of judgments makes it perfectly clear that rhetoric is a general subject. The reason why it is so hard to define courses in English and to secure uniformity in these courses is to be found in the infinite variety of ends which may be sought with identically the same text in rhetoric and identically the same illustrative material. Teachers of rhetoric recognize this fact when they say that the English teacher's personality is a very large factor — more of a factor than the personality of the teacher of mathematics. In the observations recounted above, it was fortunately unnecessary to include the petty insistence which some instructors feel obliged to exhibit about the absolutely formal matters of margin, spelling, punctuation, etc.

In the third place, one notes a strong tendency on the part of both teacher and students to seek some solid, uniform content for thought by reducing the whole exercise to a repetition of a few stereotyped phrases. The rhetoric class becomes a kind of memory exercise. Students try to answer every question in some formula from the book. One student evidently bereft of all ideas answers blandly, "The passage lacks unity." When the matter is pursued further, it does not appear that he understood either unity or the passage. This frantic devotion to the text is clear evidence of the desire of the student to get something tangible in the midst of the whirl of things. When one sees the corrected compositions of a class, he realizes why the manifold judgments which are possible and even attempted gradually get reduced to a few simple, formal matters. These formal matters can be noted with red ink with a definiteness that is quite impossible when one tries to deal with the other, larger matters that are suggested.

A visit to a rhetoric class leaves one with the impression that too much has been undertaken and too little carried through. The difficulty of organizing work in English is evidently great. The layman is led to believe that the subject should be subdivided and the parts attacked in succession.

Problems of Literature

From the discussion of modes of expression we turn to a discussion of that phase of English which is designated as literature. The business of class exercises and study in literature is to cultivate appreciation. There is a certain mysticism in the minds of many teachers about appreciation. Taste is proverbially a purely personal and quite inexplicable trait. The power of appreciation is accordingly said to rest on subconscious judgments which are very vivid but quite incapable of communication. Such statements regarding the nature of the process of appreciation are, of course, a challenge to the psychologist. Appreciation is a mental process and is capable of training under direct guidance, while to some extent it seems to mature without direct guidance. Our problem is to discover what is the mental and physiological mechanism involved in appreciation, and thus to throw light on the methods of its training. In other words, it is here, as always, the business of psychology to refuse to be satisfied with mysticism. Appreciation must be analyzed and explained.

Rhythm as a Fundamental in Literary Form

For the purposes of our study we shall begin with a very simple form of appreciation. Professor Sievers [1] has pointed out the fact that every writer and speaker has certain

[1] G. E. Sievers, Grundzüge der Phonetik, especially Cap. XXXI–XXXVI. Breitkopf und Härtel, 1893.

typical rhythms of speech and phraseology. In his lectures he goes so far as to assert that it is possible to determine the authorship of a manuscript by finding out the rhythm in which the successive phrases fall. Furthermore, he calls attention to the fact that the rhythms which express different types of emotional reaction differ from each other. Thus the writer or speaker who is excited by some intense emotion will write in short and rapid rhythm and will speak in the same fashion, whereas the long deliberate periods of unemotional discourse indicate an entirely different attitude of mind and body. These rhythms attaching to different emotional situations are recognized, though not always explicitly distinguished, from the total expression by the reader and by the author. If there is a fitness in the particular rhythm, so that the content of the sentence and its rhythm are felt to be appropriate, we speak of the style as satisfactory. If, on the other hand, there is any incongruity which gives us a content of one type and a rhythm of a wholly different type, we speak of the style as inappropriate. Undoubtedly most people are more sensitive to the rhythms in oral speech than in written speech. When, therefore, one wishes to bring out the full significance of a paragraph which expresses strong emotion he can do it best by reading it aloud. This does not mean that he should give to each word any peculiar intonation; indeed, the emotion is expressed not by single words and their emphasis, but rather by the general rhythm of the whole paragraph. Some teachers of reading make much of the principle that the voice must be raised and lowered so as to express the emotions which are carried by certain words. It is often not the change in pitch which is significant in an emotional passage. The rate at which words flow is the more significant fact.

As stated above, the ordinary individual frequently does not analyze the situation far enough to pick out the rhythm

desired. Well-arranged words thus induce rhythmical reactions, at the same time that they carry a freightage of other meanings through their appeal to other active functions of the individual.

Reactions related to Grammatical Structures

Up to this point we have dealt primarily with the rhythm of sentences and its connection with emotional life. There are, however, a great variety of other forms of reaction which are established during the cultivation of language and during the development of the ability to read. Thus, one acquires, as pointed out in the last chapter, definite modes of reaction for the different parts of speech. If one uses a preposition, there is in his experience a definite demand for an object to follow this preposition. This demand is no shadowy mental desire; it is a real physical need. It is to be explained by the fact that in expressions prepositions have always been followed by objects. We have learned prepositions and objects as a single verbal reaction. We learn to move our vocal cords in certain series of expressions and our whole motor organization is such that we feel the need of complete expressions.

Grammatical habits are real motor habits. Just as the left hand tends to follow the right in its upward and downward movements, so our phrases are expressions of our systems of speech. Our language habits are as fixed as our habits of facial expression. Let one note the kind of experience he has when a preposition is omitted. Read the partial sentence, "This book lies on . . ." The impulse to go on beyond the preposition is as strong as the impulse to look around when one hears a sound. Again, anyone who has experienced the shock of hearing a person say "With you and I" will realize how pungent is the bodily feeling which is produced by the preposition "with" followed by

the pronoun "I." One has the same kind of experience in this case as that which shocks him when he makes a false step at the top of the stairs. There is a physical jolt which is altogether out of proportion to any actual sensory experience which he encounters. The preparation and the tension of all of his muscles is in conflict with the expression which is executed contrary to his expectations.

There are other grammatical adjustments, as when one uses the subject of a sentence and starts to satisfy his feeling of the necessity for a verb. Not only is this connection between subject and predicate a definite one in the sense that the verb must follow, but the verb must be of a particular form. Anyone who has used a plural noun begins to feel the necessity of a plural verb. If the sentence becomes long and involved he may be satisfied with a verb of the wrong number. This is particularly true when qualifying words which have a number different from that of the subject are interposed between the subject and the verb itself. In all these cases, however, we have examples of definite active adjustments on the part of the speaker, which adjustments have come to be so fixed in form that if one is speaking or reading he demands the proper consummation of the expression in conformity to his habit. One will never be satisfied to have an author break through the habits of his own speech to the extent of using a singular verb with a plural subject or to the extent of using a preposition without an object. On the other hand, one is quite willing to follow an author beyond his own personal ability to develop sentence structure. There is nothing more interesting than to read a sentence which is long and involved, but which works out with perfect precision. One reads such a sentence as this, which is longer than any that he would himself construct, with a feeling of a good deal of satisfaction that the author of the sentence has been able to extricate everyone concerned from the intellectual maze.

Anyone who has struggled with the German language has an appreciation of the satisfaction which the novice feels in watching the way in which an expert in this language manages a separable verb. The moment the verb is used in a sentence, there arises a feeling of craving for the remainder of the verb. The skillful German places between the verb and the prefix a long series of phrases and words, but ultimately arrives with perfect precision at the end of the sentence, and gives the satisfaction which comes from a proper closing of the feeling which was started when the verb was first introduced. The learner is fully aware that he could not have carried the grammatical suspense forward as has the German expert, and the satisfaction at the final conclusion of the whole matter is the greater because he realizes how much the achievement surpasses any German of which he is himself capable.

Reactions related to Rhetorical Forms

In the same way one follows a public speaker, when a climax is gradually being developed, with a kind of breathless anxiety lest the climax should break down. If the climax is properly reached, there is a satisfaction which is very much greater than that which would be derived from hearing a rhetorical period which one is himself able to construct. The audience becomes more and more tense as the speaker moves to his conclusion; and the satisfaction of this tense strain, if it is properly managed and properly brought to its consummation, may be of the highest type.

In the case of a climax or of an elaborate paragraph the reaction and the experience are induced; that is, they did not originate with the auditor, but rather were taken on by him through a kind of imitation. Appreciation may thus be described as the ability to follow a series of adjustments. Appreciation does not depend upon one's ability

as a performer, but rather upon one's ability as an auditor. Illustrations of this ability to appreciate another's performance, even where one is himself not expert, can be seen in the way in which an audience will follow an expert singer. Anyone who has heard a high soprano note will understand what is meant by the statement that the audience appreciates performances which are far beyond any listener's individual possibilities. As the singer takes the high pitch which no member of the audience could imitate, there is an incipient tendency to draw one's self together in a supreme effort to follow the note which is being produced. If, for any reason, the sound is not accurately produced, there is a violent reaction of disappointment, which is so obviously a physical reaction that one who has experienced it needs no argument to persuade him that appreciation in this case is a genuine physical matter. We have the same sort of sympathy with a person who is using the muscles of his arms and back in trying to lift a great weight. It is not necessary that we should lift the weight with him in order to have sympathy with what he is doing; it is enough that our eyes see him and our muscles grow tense in watching his efforts to lift the weight.

Relations of All Emotions to Reactions

The reader who has never realized the importance of behavior in determining the character of individual consciousness has undoubtedly been growing more and more restless as the foregoing pages have omitted all mention of images and ideas and have set forth the relation of reactions to appreciation. This emphasis on reactions came into psychology with the James-Lange doctrine of the emotions. Before James wrote his great work [1] the psychologies

[1] Principles of Psychology, chaps. iv, xxiv, and xxv (Henry Holt and Company, 1890); Talks to Teachers on Psychology (Henry Holt and Company, 1902).

were utterly deficient in their treatment of emotions. There was a descriptive classification of emotions but no explanation of their character and conditions. James went further than any writers before him, and pointed out that it is evident that emotions cannot be explained by the facts of sensation. When one enjoys looking at a certain shade of blue and is displeased with a certain shade of yellow, the pleasure and displeasure attaching to these colors cannot be explained by referring to the retinal processes involved. The sensations have quality and intensity, but the feeling tone is due to the reactions which they arouse. The blue color makes the circulatory and respiratory organs act in a way wholly different from that in which they act during the observation of yellow. This doctrine worked out by James and Lange is an explanation of one group of mental processes which the sensory psychology could not deal with except in the most general descriptive terms.

The theory of the emotions sketched above has influenced psychological thought in all directions. To-day we recognize that there are many aspects of experience other than emotions which can be understood only by the study of reactions. Space as an arrangement of sensations is the product of our efforts to organize our responses to sensations. This was discussed in an earlier chapter. The facts of attention can be best understood when we refer to activity. The individual who is concentrating on an object is turning all his motor processes in the direction of that object. The processes of discrimination are processes of varied response. In short, wherever sensations are organized or arranged we are dealing with processes of behavior. The term "behavior" is not used in any large and loose sense. Behavior means bodily reaction and the nervous organization on which bodily reaction depends. The reason why right and left are so clearly distinguished is that these are sharply contrasted directions in which action may be

turned. The reason why up and down are recognized as different is the same. The reason why we classify altruistic outgoing effort as opposed to narrow selfishness is to be explained by the motor attitudes which are attached to these contrasted words and ideas.

Reaction and Individual Interpretations of Words

Another general topic which the psychology of behavior finds it very profitable to discuss is the problem of individual differences. The same sound goes in at the ears of two different individuals. We have every reason to assume that each individual experiences a sensation essentially like that of all other human beings stimulated by the same sound, but how vastly different are the results of the two stimulations! The one individual hearing the sound remains unmoved and inactive; the other is aroused to the most strenuous endeavor. The one has no organized tendencies to react to the sound; the other has. The experiences which arise in the two minds will reflect very little of the common sensation element present in both cases. No one would think of treating the two mental experiences as alike because of the like sensory factors. The real character of each mental process depends on the mode of response of which the individual is capable. It is the reaction side of human nature which is significant.

The same conclusion appears when one studies the development of an individual. The child and the man both see the same object, but the man knows what to do in the presence of the object and the child does not. Psychology and teaching are concerned with reactions; sensations are important only in so far as they arouse reactions.

This long digression from our study of appreciation has perhaps served to persuade the reader to assume toward

language and language teaching an attitude different from that assumed in the conventional explanation of words as merely clues to mental pictures. Words are vital, significant facts in the mental world. We have word habits. We have modes of expression. We demand in all our contact with others that our habits of verbal reaction shall be conciliated.

Psychology of Style

Such general statements can be supplemented by further details. In colloquial speech with one's familiar friends, one has a certain type of articulation and a certain set of familiar phrases. The moment one gets out of this friendly environment into a group of strangers one finds that his mode of articulation and his phraseology take on an entirely different character. He uses more dignified words, and he drops the familiar phrases which he used with his friends. One has, therefore, a style of familiar speech and a style of public address. One has a style for strangers and a style for friends. These are modes of behavior.

In the same way one has a style of written expression which distinguishes itself sharply from his style of oral expression. In his autobiographical notes Herbert Spencer calls attention to the fact that he finds his practice of dictation leads to a diffuseness and looseness of style which was not exhibited in his earlier work, when he wrote his books with his own hand. This looseness of style in dictation is in part connected with the fact that one does not see the products of his work with the same degree of definiteness as when he is writing, but there is also the general fact that the words which issue from one's vocal cords are different in character and in their connections from the words which one writes with a pencil or pen. The habits of expression in the two spheres of action are different.

Perhaps this difference in style can be most clearly illustrated by the confession of a psychologist, who said that as a boy he had acquired the habit of profanity, but never made the mistake of using any of his profane phrases in his conversation at home. He did not have to stop and think each time he said anything at home that he must avoid profanity. He simply had a nonprofane style at home, whereas when he was associating with his companions he had a style which included a free use of profane words. Later in life he resolved to give up the use of profanity altogether. Then he found that his profane phrases crept into his conversation both at home and away from home. In other words, the profane phrases in this case crept in only when he did not detect them and eliminate them, and during this period of elimination they broke up his habits of expression both at home and away from home.

Such examples of different kinds of style in different situations could be multiplied indefinitely. One has a serious style of address when he is engaged in one of his profound technical discussions, which serious style of address differs altogether from the style of address which he would use if he were discussing matters of business or politics with his audience. Many an academic man realizes that he can lecture very much better than he can write. His lectures are clear and explicit and attractive to the students whom he sees before him. The moment he loses the stimulus of the class environment and sits down with pencil and paper and tries to write out his ideas, he becomes heavy and unintelligible. On the other hand, there are many people who would be utterly at a loss to express themselves in oral speech. If they were suddenly placed before an audience and called upon to express ideas, they would find the whole machinery of expression blocked. The only hope for such people is to write out what they have to say and then read it. Some people are able, when

given this opportunity of writing out deliberately what they have to say, to prepare a fluent and coherent statement of the situation. They have a habit of written expression which is superior to their style of oral speech.

Continuity of Discourse a Mark of Maturity

Finally, one further illustration may be offered which distinguishes the trained individual from the untrained individual. The trained individual feels the necessity of keeping up the continuity of thought and statement. He uses certain connective words and phrases which carry him over from sentence to sentence and from phrase to phrase. He uses at the beginning of a paragraph such a connective word as nevertheless or accordingly. The untrained thinker, on the other hand, omits most of these connective words. His ideas come in disconnected units. He does not feel the necessity of carrying the reader or his own discourse forward from phrase to phrase. He speaks in short, choppy sentences, and he is likely to use the wrong connective word if he tries to bridge over one of the chasms in his thought and expression. Something analogous to this appears in the mature writings of a poet. It requires a high degree of development of the poetical art to bridge over the formal breaks in versification; it is a mark of complete mastery of verse forms to adhere to the laws of division dictated by the meter and, at the same time, to carry forward the idea when need be beyond the line in such a way as to avoid gross inversion of speech and sharp breaks in sentences.

Summary of Reaction to Form

Enough has been said in these examples to make it clear that style grows through the accumulation of a great variety of habits of speech and expression which cannot be

connected with single words, but which control the formation of sentences and paragraphs. Furthermore, it has been made clear that the appreciation of these sentences and paragraph structures does not depend upon the ability of the individual himself to originate the forms of expression which he enjoys. Finally, attention can be called once more to the fact that in many cases the learning of one of these forms of sentence reaction is greatly facilitated by oral reading as distinguished from silent reading. The habits involved in appreciating matter which has only been seen are undoubtedly different in character from the habits involved in appreciating that which is expressed aloud.

Reactions to Content

Appreciation of rhythm, of structural facts, and of style constitute what we may call the pure forms of rhetorical appreciation. There is an entirely different sphere of appreciation. A literary passage is appreciated by the trained reader for its content as well as for its form. Appreciation of content is in essence the same kind of a mental process as the appreciation of form. Content is enjoyed just in the degree in which the individual's habits of reaction are satisfied by the impulses aroused by what he reads. Or to put the matter in a negative example, an individual can appreciate fully an emotion which is expressed in a poem only after he has had some of the real experiences capable of arousing in him modes of response appropriate to the sentiment expressed in the poem. Take, for example, such a poem as Whittier's "Barefoot Boy." It is sometimes assumed that because this poem is about a boy it ought to be given to boys to read. It is assumed that boys will be aroused by the sentiment which the author experienced when he contrasted the boy and his simple surroundings and possessions with the unhappy man of wealth who

is deprived of all of the physical enjoyments which the barefoot boy enjoys. The fact is, of course, that an ordinary boy who has had the privilege of going barefooted has probably never had the remotest approach to that emotional recoil against luxury experienced by the man of wealth who rides by in his carriage. In other words, the barefoot boy cannot appreciate the discomforts of luxury which are described to him because the description arouses in him no response. In order to have the contrast which is in the poet's mind, he must have had maturity of experience and the recoil of disappointment. To the ordinary boy no such contrast in experience is possible. He sees the matter only from one uniform level of meager personal experience, and this leaves him without any possible appreciation of the author's point of view.

What has been said in connection with this example is frequently stated in discussions of appreciation when it is pointed out that one must have had some contact with life before he can fully comprehend the meaning of literature. Undoubtedly one must have cultivated certain forms of emotional reaction and certain forms of interpreting experiences before he can know what ideas mean. It is not that one needs merely to know words, one must know how to relate words to the larger experiences of life. Every individual word in the poem may be known to the barefoot boy. Every sentence may be capable of perfectly definite explanation, and yet one may have no appreciation whatsoever of the sentiments which the phrases ought to bring up. The total situation is the mature product of many experiences. It is not even a matter of interpretation of a given sentence. There is undoubtedly a good deal of failure in the schools to appreciate this fact. We give literature to high-school students without any proper backing of personal experience to interpret the significance of the passage. The result is that the student's mind is concentrated upon the purely formal side of the passage. He

is absorbed in the words and in the sentences as they are presented on the page, and he fails to have any appreciation of the real significance of the passage because appreciation in this case means a response of a large and mature type. It would be very much better in such cases to find passages which can be related to reactions of which the learner is capable. Not that the passages should forever remain below the level of present experience, merely depending on the accumulations of the past to interpret what is now given; each passage read should refine the evaluations given to life's contrasts; each passage should bring out some new analogy and some worthy difference. But these new contributions to experience must be close enough to that which the individual now has, so that a real relation may be established in the learner's mind. Literary content must not merely be given. It must arouse a response. The student must feel the contrast or the agreement. He will thus be prepared to face in later life more elaborate comparisons and more elaborate interpretations. He cannot, on the other hand, be prepared for the later appreciation of literature or for the relating of life and literature if the habits of mind which are cultivated in the school are formal habits of attention to words and sentences. A strict attention to the text in such cases as this is likely to pervert rather than to aid the student's literary development. He gets a bad habit of thinking of poems and of prose passages as things in themselves, as groups of words, as occasions for barren rhetorical, grammatical, or analytical drill.

Studies about Selections *versus* Appreciation

There is another perverted form of instruction which is very common in the schools. It assumes that students will get some notion of the meaning of passages by hearing about these passages and about their authors. There is

undoubtedly some value in the information which is given in the history of literature, but the history of literature as a list of names is certainly not to be identified with training in appreciation of literature. To learn about the conditions under which a poem was written may indeed throw some light upon the significance of the author's mood and the meaning of the passage, but too frequently a statement about the conditions under which the poem was written becomes itself a remote and distracting subject of attention. The student is distracted from the poem itself to think about a series of facts or statements which are of little or no value in promoting his interpretation of what he reads.

Dangers of Dissection

Formalism very frequently appears in another practice. The literary passage is dissected in such a way that each item of information which is presented is scrutinized and made the subject of long comment. Each individual paragraph is studied apart from its place in the total composition. All of the allusions must be looked up, and the student becomes absorbed in the history of classical mythology rather than in the turn which is given to the passage by the reference to some classical story. This breaking up of a passage into its elements is very dangerous, because attention is in this case frequently drawn away from the real centers of emphasis. An allusion is frequently a remote suggestion of something that ought to be included in the thought rather than an appropriate subject for long discussions and attention.

It is not denied that explanations and intelligent comprehension of an allusion may be necessary. If the student does not know who Hercules was, it is sometimes necessary to study the whole myth in connection with the use of the single adjective "Herculean"; but what the student should

carry away from this study of an allusion is the merest remnant of the whole story, the intellectual deposit of the discussion, rather than the long-drawn-out statement of the myth itself. Herculean means something large or strong or noble. That is what the student ought to be required to carry away from his study of classical mythology in this particular instance. He ought not to have to break up the passage the next time he reads it and go into a long discourse on all of the feats of strength which the hero accomplished, otherwise the flavor of the adjective will be lost in a didactic discussion of the information which came out of the classical dictionary.

How English teachers expect to create appreciation of "Ivanhoe" or "Miles Standish" by drilling into the student's mind all of the details that can be looked up in commentaries and books of information is indeed difficult for an outsider to understand. The student gets the impression that the reading of one of these classics involves an encyclopedic inquiry into history and art. He loses the story itself in the multitude of explanatory considerations that are clustered about it. He is not encouraged to boil his experiences down to the point where they shall be mere interpretations of words. He is encouraged all the time to elaborate every word into a long and dreary series of explanatory ideas.

Instruction in Appreciation

Perhaps the best antidote for formalism of the type which has been under discussion in the last paragraphs is to point out the fact that attention to form of expression is often the best possible means of securing appreciation of a passage. The writer recalls with grateful appreciation the skill with which his college teacher of English literature gave him a lesson in literary interpretation by compelling him to contrast two lines in Hamlet which were being read

orally in class. In the fifth scene of the first act Hamlet, replying to the Ghost's injunction "Remember me," says:

> Remember thee!
> Ay, thou poor ghost, while memory holds a seat
> In this distracted globe. Remember thee!
> Yea, from the table of my memory
> I'll wipe away all trivial fond records.

The recurring exclamations "Remember thee!" had been read in the first instance with the same intonation. The instructor called attention to the desirability of distinguishing the two phrases in the two cases. Finally, the learner saw that the first "Remember thee" emphasized the word "remember," the second the word "thee." From that moment on the effort to interpret all the lines in the drama was of a wholly different type. The teacher had taught discrimination. This discrimination was a matter of form; but it reacted on content, and content became significant and illuminating from the moment the discrimination was clearly made. The study of what may be called internal form as distinguished from the study of external outstanding facts is shown by such an example to be productive in a high degree.

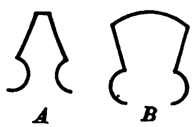
This example could be multiplied by many another which would reënforce the general position defended all through this chapter, that appreciation is a matter of discriminating reaction. There is no mystery about appreciation in a psychology which lays as much emphasis on reaction as it does on imagery.

Variety and Complexity of Appreciative Reactions

There is one question which has undoubtedly suggested itself to the mind of the reader who is not in sympathy with this type of psychology. Such a reader has doubtless noted that nothing very specific has been said about the actual

muscular contractions which appear in the interpreting reactions. What are the forms of muscular contractions which result from the reading of Milton's "Comus," and how do they differ from the contractions induced by reading the jokes in the daily paper? The simple and straightforward answer to this question is that we do not know very much about these details. Probably there are vast individual differences which can be understood only when it is recognized that all the active habits of an individual are involved in any one act. These individual differences account for the highly subjective character of our tastes and appreciations, while at the same time they baffle the student who would give a general scientific explanation.

Professor Sievers has of late been trying some interesting experiments in the reactions which connect themselves with literary appreciation. He sets before the reader sharply contrasted passages, one containing such adjectives as "narrow" and "straight," the other full of suggestions of a broad horizon.



With these passages are supplied certain visual figures, two of which are shown above. When the figure *A* is presented, with a passage about a narrow, straight path, the result is a reading of the passage with a reënforced tendency toward emphasis on the narrowness and straightness of the road. When, on the other hand, the reader looks at *B* and tries to read the passage about a narrow road, there is a curious feeling of incongruity and a strain in the act of reading. Professor Sievers explains this phenomenon as due to the induced muscular contractions in the trunk muscles which result from recognition of the figure. Converse results appear when one uses the figures *A* and *B* with the passage referring to free space.

These experiments suggest fruitful lines of investigation and, at the same time, supply the answer to our critical

reader. Our psychology has been so absorbed up to this time in the study of impressions that it has not dealt adequately with reactions. Hence we are not equipped with details. We are, however, supported in our generalizations by a growing body of evidence.

Development of Interpretations

With this psychological analysis of literary appreciation we may turn to several of the practical implications of the doctrines which have been developed. In the first place, one realizes that literary appreciation depends upon the growth of experience. Little children cannot be expected to have very much literary appreciation. Their appreciation is keen for such primitive characteristics as the rhythmic forms of speech. The content of the primitive rhythms most readily appreciated is a curious mixture of narrative and nonsense. The little child enjoys Mother Goose quite as much as he would enjoy a poem full of sound, wholesome moral doctrines, for in any case the content is subordinated to the rhythm. He enjoys the Mother Goose because it makes an appeal to his sense of rhythm and because the words arouse all sorts of familiar reactions in a confusing but stimulating medley.

With the growth of more mature ideas there is an increasing emphasis on the reactions which are aroused by the content, but we cannot depend upon literature alone to create an appreciation of the larger experiences of life. We cannot depend upon any study of a verbal type to create a large appreciation of one's social relations. One must have come in contact with social relations and must have seen his dependence upon his neighbors in such a way that he reacts to the whole social environment with some degree of intelligence before he can have a full appreciation of verbal statements which call attention to his contact with his fellows.

On the other hand, it should be recognized at once that verbal descriptions help the student to see the contrasting factors of his world of experiences. Point out to a child that some acts are good and moral and others are bad and immoral, and he will forever after be more keenly aware of this contrast than he was before he received the instruction contained in those words. Words are themselves significant reactions, and one's organization of experience depends on their use. Words help to mature one's ideas of the world. Literary appreciation is thus seen to be a developing agency as well as a result.

Examples as Means of Literary Instruction

Another application of our studies is seen in the fact that literature is a means of modifying one's own mode of speech and writing. We must accordingly consider the relation of appreciation of the writings of others to one's own modes of expression. It is a fundamental mistake to assume that a child must be able to produce a literary passage in order to appreciate it. Indeed, the mere shock of contrast between what he would himself do in a given case and what some writer has done for him is perhaps the most significant contribution which can be made to the student's education. That student who is confronted day after day by his own productions is likely to find his habits of expression and thought very much narrowed by this contact with his own work. Bad habits of expression become fixed, and the general level of mediocrity is established, from which there is no escape. If there is anything that composition has demonstrated in the schools, it is that students may be correct within the limits of their own possibilities of expression and yet be most commonplace in all that they say and write. The teacher hardly knows how to tell the mediocre student what is wrong. What the teacher would like to

say to the student is, perhaps, something like this: "Your sentences are all right, but they show no variety in form. There is no pleasing æsthetic change in the modes of expression. There is no spontaneity and change of temper from paragraph to paragraph. Get some variety into your writing." A student thus addressed by a teacher would be wholly at a loss to know what is meant. He has laboriously hammered out one sentence after another, painfully expressing the best that he had in each of these sentences, and now the teacher comes to him with the preposterous criticism that this is all right and yet worthless. What that student needs is to come in contact with somebody else and hear somebody else's longer sentences and variety of expression. He needs to be taken out of his own limited sphere of thought and language and introduced to a sphere of thought and language created by someone who has a broader experience and broader scope of language. The introduction of a student to this higher and more elaborate sphere of expression is attended by all sorts of difficulties, to which attention has been called. There is danger that he will be suddenly elevated into an atmosphere which he cannot breathe. He will fail to appreciate what he reads because it is so far beyond his comprehension that he is entirely lost in his efforts to understand the meaning of the passages before him. The teacher, in the meantime, being a person of wider experience and broader training, will have no sympathy with the inability of the student to react upon this larger body of ideas, or else he will become so accustomed to the immaturity of his students that he will himself be dragged down to the level of the immature thought of his class. It is a pathetic sight to see some teacher of literature who probably once realized that "Julius Cæsar" was worth reading, trying to get this drama down to the point where it can at least be recited upon by his class. Teacher and students alike have lost all appreciation in

the effort to cram the text into the narrow spaces which are furnished by the comprehension of the immature class and the bored teacher.

Training in Vernacular must be broadened

Finally, the outcome of our study must be the conviction that the gravest problem of English teaching is to train in the broad appreciation of all kinds of material, while at the same time we subject all kinds of materials to the refining effects of literary formulation. The student will bring new ideas to the English class from the preceding recitation in science. The teacher ought to be able to utilize this experience, and ought to send back to the science class the advantages which would come if the student knew how to express in clear, well-arranged sentences the findings of his scientific study. We have some experiments in this direction.

The Cicero Township High School has a formulated series of requirements in English which are enforced in all classes. The author is indebted to Principal H. V. Church for the following series of "direction sheets" used in carrying out this plan.

PLAN OF GENERAL ENGLISH INSTRUCTION IN CICERO TOWNSHIP HIGH SCHOOL

The following requirements shall be enforced in all departments, and shall be the basis for the English grade:

ENGLISH 1

First Semester. First Month

Oral. 1. Not more than twenty-five per cent of the recitation shall be in incomplete sentences. These recitations may be given while the pupil is seated.

2. The careful enunciation of syllables, particularly of final syllables, shall be insisted upon.

Written. 1. Balanced margins shall be maintained both at the top and bottom and at the sides of the page on which the written composition is placed.

2. Paragraphs shall be indented.

3. Sentences shall begin with capitals.

4. Sentences shall close with periods.

5. The use of incomplete sentences shall not be allowed.

6. Written work shall be legible.

7. A liberal space shall intervene between consecutive lines and consecutive words.

First Semester. Second Month

Oral. 3. If the recitation gives promise of continuing for several sentences, the pupil shall rise and stand erect and free.

Written. 8. The use of commas in series shall be insisted upon.

First Semester. Third Month

Oral. 4. Sentences shall not be introduced with such words as "why," "well," "ah," etc.

Written. 9. The use of long, straggling compound sentences shall not be permitted.

First Semester. Fourth Month

Oral. 5. The use of slang shall not be permitted.

Written. 10. The use of slang shall not be permitted.

ENGLISH 1

Second Semester. First Month

Oral. 6. The discriminating use of words peculiar to your department shall be inculcated.

Written. 11. Opening sentences of paragraphs shall contain a topic statement.

Second Semester. Third Month

Oral. 7. Opening sentences of paragraphs shall contain a topic statement.

Written. 12. Single paragraphs, especially those of considerable length, and the closing paragraphs of related paragraphs, shall be concluded with a summarizing statement.

ENGLISH 2

First Semester. First Month

Oral. 8. If the recitation is of the nature of a report, or lengthens to a paragraph, the pupil shall stand in front of the room before the class.

Written. 13. A dependent clause standing first in the sentence shall be followed by a comma.

First Semester. Second Month

Oral. 9. Errors in grammar shall not be permitted.

Written. 14. In a compound sentence, independent clauses not closely related shall be separated by a comma.

First Semester. Third Month

Oral. 10. Recitations shall be audible to all.

Written. 15. Parenthetical material shall be set off by commas.

First Semester. Fourth Month

Oral. 11. In talking on a topic, the pupils shall look their classmates in the eyes and assume a free and easy position.

Reorganization in Direction of Generalization

These and like requirements are to be imposed on the science class and the mathematics class by the teachers of science and mathematics for the sake of clearness in science and mathematics. Such requirements are good and they generalize English in spite of the English teachers.

On the other hand, the English teachers are induced in other high schools to require or allow science themes and history themes. This coördination is usually opposed on

both sides. The science and history teachers object that the English teachers do not understand the subject matter. The English teacher usually assents to the objection raised by the other departments, and adds the fact that all English teachers are overworked. The net result, after a spasm of correlation, is usually a smug and complacent retirement of English into its own peculiar field, while science and history turn to the task of cultivating subject matter, and incidentally requiring periods now and then at the end of sentences.

The formula which suggests itself to the nonpartisan outsider is one of readjustment. Let us find someone bold enough to try the following experiment: Teach in one course the elements of form. Make it a good course, frankly dealing with sentence and paragraph structure. Then teach some of the history of literature, and train students to read, not dissect, some of the literary masterpieces. Then relieve the English department of further duties, so far as required work in the school is concerned. Take the time that would thus be saved and give it to history and science, but add the requirement that these courses be conducted in the English language, and not in the ejaculatory and explosive monosyllabic pretenses at expression now commonly tolerated.

CHAPTER X

FOREIGN LANGUAGES

The psychologist experiences little or no difficulty in finding material for his discussions in the field of the teaching of foreign languages. From the earliest period of such instruction, teachers have discussed the principles of mental operation which underlie their methods. The psychologist could confine his efforts to a review of the various methods and of what has been said in support of them if it were not for fact that there are such glaring disagreements in the statements made by language teachers that he is compelled to add critical comments to his reviews.

METHOD OF THIS CHAPTER

Our method of procedure in this chapter will accordingly differ from the method adopted in discussing mathematics and English. We shall examine critically certain of the more important discussions of the teaching of foreign languages. We are forced to select from the great mass of material which is at hand, otherwise we should be led into too lengthy a treatment of this single field. The reader who wishes to go more fully into the history of these discussions should take in hand some of the special discussions of methods in the classics [1] and modern languages.[2]

[1] C. E. Bennett and G. P. Bristol, The Teaching of Latin and Greek. Longmans, Green, & Co., 1906.

[2] For a general discussion of this matter as well as the history of the teaching of modern languages see *Teachers College Record*, May, 1903, Vol. IV, No. 3, pp. 1–92. This is also published as a separate volume under the title, The Teaching of Modern Languages, by Leopold Bahlsen (translated by M. B. Evans). Ginn and Company, 1905.

For our purposes it is not important that we should distinguish sharply between the classics and the modern languages. Since the more recent and more vigorous discussions of methods relate to modern languages, we shall pay attention chiefly to these rather than to the classics.

Before entering upon the discussion of methods it may be well to point out the urgent need of an impersonal, scientific study of our problem. Many recent discussions have been of a bitter partisan type. Particularly during the last fifty years, since Herbert Spencer made his pointed attack upon classical education, there has been exhibited, especially among those interested in the newer subjects, a very intolerant attitude toward foreign-language instruction. The classics above all, and to some extent the modern languages, have been called upon to indicate the grounds on which they can properly maintain their position in the curriculum.

Grounds urged in Favor of requiring Languages

In answer to this challenge the defenders of the languages have urged three justifications for their courses: first, languages are supposed to give a type of mental training which is advantageous quite apart from the content which the text supplies; second, the study of a foreign language is said to be very advantageous in clearing up a student's notion of his own language, both in matters of structure and in matters of vocabulary; finally, the study of a foreign language is supposed to be the means of bringing the student into contact with a culture other than that which he knows in his native land.[1]

The first two arguments are psychological in type and have been elaborately argued on both sides. Indeed, in a

[1] F. W. Kelsey, Latin and Greek in American Education. The Macmillan Company, 1911.

very important sense the languages, because they are the subjects which have long held leading place in the curriculum, have had to take the brunt of a psychological discussion which is in reality very general in its scope. For example, the general doctrine that a subject may be studied with advantage quite apart from the content of the text is an argument that has been presented by every subject in the curriculum at some time or other. But the classics have presented this argument with such clearness and such force that they have become the center of the debate. The classics, more than any other subject, have been charged with support of the general doctrine of formal discipline. As a matter of fact, the natural sciences have assumed more commonly than the classics the validity of this principle of formal discipline. When one considers that the various sciences in the curriculum have been satisfied to give very short courses, on the theory that if a student were introduced to the methods of the science he would be able to carry these methods over into all sorts of situations that have not been canvassed in the class itself, one sees that the sciences have been assuming, in very large measure, that training given in a brief course will carry over into all sorts of varying situations. The advocates of sciences have been exultant in the recent criticisms of formal discipline, and they have charged the classical languages with maintaining this doctrine in opposition to evidence, while these same advocates have tried to justify the position of the sciences in the school program by an appeal to the value of scientific method and to the training which their subjects give in observation and reasoning. These scientific critics of formal discipline very seldom make reference to Herbert Spencer's argument regarding the formal value of science in his first essay on "Education." They write paragraphs that can be quoted, as we shall show later, in support of the most extreme form of the doctrine of formal

discipline, while they criticize the classics violently for the defense of what they regard as an antiquated and abandoned theory. The general discussion of the doctrine of formal discipline is of such importance that we shall devote a later chapter to this subject. For our present purposes it is enough to call attention to the fact that the languages have borne an undue share of this general discussion just because they are in point of method and in point of pedagogical theory more mature than the other subjects of the curriculum.

Partisan Discussions obscure Issues

With regard to the second and third arguments for language study it may be remarked that the truth is sadly obscured by the most violent partisan statements. In recent years English, as a special subject, has received so much attention in the course of study that there is less patience than there otherwise would be with the second argument. The third leads to enthusiastic comments on classical civilizations on the one side and to the bitterest attacks on classical culture on the other.

There is indeed a certain psychological phenomenon in the very partisanship which is here observed. The psychology of a violent reaction is always an interesting topic for the student of social life, and there can be no doubt that we have here a violent reaction. There was a time when the classical languages were so in control of the curriculum that there was no disposition to question the pedagogical wisdom of administering to every student a great deal of language instruction. It took generations of dissatisfaction with the methods employed in language instruction and with the results that come from this instruction to prepare the way for the attitude which many now assume toward the languages. Furthermore, after the storm began to rise, friends of the classics made what now appears to have been

a grave strategical blunder. They attempted by sheer administrative authority to require the languages, and thus they alienated those who otherwise would have been prepared to discuss the advantages and disadvantages of these subjects in a purely impersonal way. It must be admitted also that the friends of the classics have not been wise in their day and generation, for they have been slow to change their methods of teaching in such a way as to meet the legitimate demands of the modern curriculum. The modern curriculum is not, as was pointed out in the introductory discussion, a series of courses intended for the student who is specializing with a view to entering the professions. The modern high-school course of study is offered to a very wide and cosmopolitan constituency. Whatever may have been true of the boys of the middle of the last century, it certainly is not true at the present time that every student will benefit by a long and rigorous course in the classics or in one of the foreign modern languages. Perhaps we shall find later, as we become more experienced in the administration of the type of high-school course which we now have, that brief courses in a great many different subjects are not the most desirable type of courses. But at the present moment such general courses are administered in practically every department except the languages. Students certainly have a right to ask, at the end of a year of work in any subject, that they carry away something that is of real importance in their intellectual development. Language teachers, accustomed to having a major place on the school program, are very intolerant of any suggestion that they ought to give the student something that is of real intellectual value in so short a period as a single year. This unwillingness of the language teachers to accommodate their subjects in any wise to the general spirit of the modern curriculum is undoubtedly disadvantageous to their subject.

General Courses Desirable

We shall have occasion later to point out that there are possibilities in language study of a generalized treatment of language which would be very useful to a student who does not intend to read the language with success or to become directly acquainted with its literature. But such a generalized course in language requires the highest type of genius on the part of the instructor and on the part of the department which is to organize it.[1] Teachers of language have very seldom seen the possibilities of such a language course. It is to be reiterated that such language courses are at least thinkable, and for the sake of their own departments teachers should give them careful consideration. If the languages would make a genuine effort to interest students by putting in the foreground some of the general principles of language structure, thus using the rich body of material which is known to comparative philology, there can be no doubt at all that much of the prejudice against the long courses which are now required as the only means of studying language would tend to disappear. Furthermore, if the administrative device of trying to bolster up the languages by requirements of a type which none of the other subjects adopt were abandoned by the defenders of these subjects, there can be no doubt that the general emotional tone of the educational world toward language instruction would be materially modified.

We must, however, come back from this digression into the psychology of social reactions and devote ourselves to the psychology of foreign languages. It is to be hoped that the purpose of this digression will be served, in that the reader will be prepared to lay aside prejudices either for or

[1] Indirectly the report of the Joint Committee on Grammatical Nomenclature is of interest to the advocate of such a generalized course. *Proceedings of the National Education Association*, 1913, pp. 315 ff.

against language instruction and devote himself for a time to the single problem, What are the psychological problems involved in such instruction?

Report of the Committee of Twelve

Turning to the various methods which have been suggested for language teaching, we find an excellent summary in the report of the Committee of Twelve of the Modern Language Association of America. This report was presented to the Modern Language Association in 1898. It was reported also to the National Educational Association.[1]

Grammatical Method

The first method which is discussed in this report is the grammatical method. When this method is followed, a series of paradigms are presented to the student before he is introduced to sentences or to the study of a consecutive text. After mastering a number of the forms, the student is introduced to the simple rules of syntax, and sentences illustrating these facts of syntax are constructed out of the words which he has encountered. He is also required to translate simple sentences from the vernacular into the foreign language. This again is for purposes of illustrating the rules of syntax which are given to him in the grammar. Finally, after a considerable period the student is allowed to read some of the classics of the foreign language; but the reading is slow, and a good deal of attention is given to the parsing of words, with a view to training the student in the details of grammatical structure.

[1] Report of the Commissioner of Education of the United States, whole number 158, Vol. II, pp. 1391–1433, for the year 1897–1898. Printed by the government printing office in 1899. Also *Proceedings of the National Education Association*, 1899, pp. 707–755.

The Committee of Twelve presents arguments for and against this method. "It trains the mnemonic faculty. . . . The careful study of grammatical rules and their nice application in translation and composition form one of the best possible exercises in close reasoning."

These two arguments in favor of the method hardly need to be restated in psychological form. They both assume that certain mental powers need to be trained, without reference to the content of the text which is being read. We have had occasion in an earlier connection to comment on the present-day attitude toward memory work. In referring to some of the discussions in mathematics, it will be remembered that it was pointed out that at the present time there is a violent reaction against the view that the memory ought to be trained. Furthermore, since William James wrote his chapter on memory,[1] grave question arises against any view which assumes that the training of the memory in one field aids memory in other fields of experience.

The second argument in favor of the grammatical method is purely and simply an argument in favor of formal discipline, and we can dispose of the matter by referring forward to a later special chapter on this subject.

Against the grammatical method the Committee of Twelve argues that it omits "the broadening of the mind through contact with life . . . and the cultivation of the artistic sense by the appreciative study of literary masterpieces. . . ." Furthermore, the grammatical method fails to stimulate and maintain the interest of students.

We are led in the first of these arguments against the grammatical method back to one of the general contentions in favor of the study of foreign language. As pointed out above, when advocates defend foreign languages in the secondary-school course, on the ground of the value of

[1] Principles of Psychology, Vol. I, chap. xvi, especially pp. 663 ff. Henry Holt and Company, 1890.

the content of texts, we are dealing with an argument that is not psychological in its character, and we need not take it up in any detail.

Psychology of Interest

The contention that the grammatical method does not maintain interest is so general that if one attempts to subject it to a psychological analysis, he is led into the broad and somewhat vague discussions which characterize the Herbartian pedagogy. This pedagogy emphasized interest as one of the most important psychological concepts for the teacher. The conflicting interpretations that have been put on the Herbartian doctrine of interest justify us in passing on to more definite problems without any attempt to revive the discussions that center about this word.

Analysis as a Product of Language Study

The discussion of the grammatical method brings us into one of the very general problems of education. Every mental process involves a certain degree of analysis. The analysis of spatial experiences was fully illustrated in an earlier chapter.

Grammatical studies are analytical studies. The sentence is taken apart and its various elements and their relations are examined in detail. The question which confronts the teacher is not, Should analysis be made? for sooner or later the sentence will be analyzed by any careful reader. The question is rather when and how shall the analysis be made. As to when, it is now very generally agreed that students should not be called on to analyze any body of experience until they have in their own minds some examples of the matter which is to be analyzed. Further, it is agreed that complete analysis is the function of the mature mind rather than of the child's mind.

Reaction on Vernacular

We may therefore argue that analysis of grammatical structures is very properly a function of education at its higher levels. One of the advantages of studying a foreign language is that such a language lends itself more readily to a scientific study than does the vernacular. The point of view which one has toward his vernacular is an intimate unanalytical point of view; he is not explicitly aware of the fact that language has structure. He never takes a view of his native tongue from what might be called the outsider's point of view. He is always using this language, and its structural peculiarities seem to him to be so natural that they seldom arouse in his mind any questions. If now the school can, through instruction in foreign language, develop a wholly new point of view with regard to language, it will certainly contribute to the student's training. Hence, as is often pointed out, a foreign language is the best instrument with which to teach English grammar. The abstractness of English grammar as it was taught a generation ago in the upper grades of the elementary schools has led to an abandonment, for the most part, of that type of study. Some substitute for this old-fashioned abstract grammar certainly must be found, and one of the difficulties in finding a substitute arises from the fact that English has so little structure of its own, either in inflection or in the principles under which its sentences are put together, that it is difficult to give a student the notions of language structure through the use of our highly simplified language. Furthermore, as stated above, the analytical point of view is not easy to assume.

If now we can use a foreign language as a basis of comparison and can, at the same time, give the essential principles of this foreign grammar, we shall gain a double advantage, because the student from the outset can assume

toward the foreign language an entirely different attitude from that which he takes toward his own tongue. When the advantages of teaching foreign language are finally formulated by teachers of language, this argument for a clear understanding of the structure of the vernacular will doubtless survive as one of the most important reasons for teaching foreign languages.

Analytical Attitude Natural to Adults

Two further comments suggest themselves: first, an adult who is attacking a foreign language for the first time will naturally assume from the outset an analytical attitude toward the study because much of his training has made him analytical in his habits of thought; second, a foreign language might be used for the purpose of training the student in analysis without carrying him very far into a reading or speaking command of the language. The argument for such scientific studies of language will be presented more fully after we have canvassed other contributing lines of thought.

Natural Method

The foregoing discussion has anticipated in a measure the treatment of the second method of teaching foreign languages discussed by the Committee of Twelve; namely, the natural method. The fundamental teaching of this method is that the adult should acquire a foreign language in the same way that a child masters his mother tongue.

In criticism of this method the Committee calls attention to the fact that the advocates of the natural method "overlook, first, the fact that the child requires eight or ten years of incessant practice to gain even a tolerable command of his own tongue, and, secondly, the vast difference between

the mind of the baby and that of the youth." To show the difference between the mature and immature mind the Committee considers the facts of pronunciation, calling attention to the observation that a little child learns by imitation, while the boy of maturer years does not imitate, but rather selects from the stock of acquired modes of pronunciation one which he applies to the present situation.

This illustration is a very suggestive one from the point of view of psychological analysis. Undoubtedly the authors of the Committee's report had in mind the contentions of those who have, of late, been describing the phonetic method of teaching the pronunciation of foreign languages. Perhaps the simplest way of reënforcing their statement that there is a difference in the mode of learning pronunciation in the later stages of life is to repeat a paragraph published by a recent writer in the *School Review*.[1]

PRONUNCIATION; IMITATION *VERSUS* PHONIC ANALYSIS

In the November, 1913, *School Review*, M. Locard has an article entitled "French in the Public High Schools." In trying to demonstrate that conversational French is inadvisable, M. Locard affirms: "It seems rational to say that French nationality, backed by education and experience, is the absolute requisite for any person who claims to teach French. A German, an American, a Japanese may have mastered the language to some extent, but with few exceptions, the standard of his pronunciation will always be below that of any mature Frenchman." Thus are we to conclude that the requisite for teaching French pronunciation is a good pronunciation? The French nation, as regards the teaching of English and German, has answered this question in the negative. In Paris the teaching of English is intrusted to Frenchmen. In visiting eight of the largest French lycées I met but one native English teacher, and she was permitted to teach permanently only because she had been naturalized. French is taught in Germany by Germans

[1] A. G. Bovee, *School Review*, June, 1914, Vol. XXII, No. 6, p. 417.

with most excellent results. Professor Walter of Frankfurt, who evidently does not talk like a Frenchman, succeeds in getting a very superior pronunciation from his pupils. Professor Vietor of Marburg gives his students of English a pronunciation which is almost impeccable. We fear that M. Locard's statement will scarcely bear comprehensive examination. Pronunciation is not contagious; a little knowledge of the science of phonetics easily turns the balance against the native teacher. Then, too, the native teacher is generally entirely lacking in any scientific preparation for this work.

Put into psychological terms this statement means that the control of the vocal cords and of the other organs of articulation can be learned by finding out in detail the various positions which these organs should assume with reference to each other when one makes a sound. The child does not know anything about his organs, and consequently has only one possible way of learning to make sounds. He must try a variety of experiments and must, through experimentation and close attention to adults about him, ultimately learn their methods of making sounds through sheer trial and error. The adult, on the other hand, is fully equipped with mature habits of making sounds. If these mature habits are not counteracted by some explicit corrective method, there is grave danger that the learner's attention will never be turned to the example of his teacher, and that he will not be docile enough in his trials and errors to assure any modification of his own natural method of producing related sounds. The more mature the learner, the worse he is as an imitator. The concrete cases cited above by Mr. Bovee go to show that the phonetic study of sounds has great advantages for mature students and mature teachers as contrasted with the purely imitative method advocated by those who defend the natural method of teaching foreign languages. The whole argument is psychologically sound and shows clearly one of the fallacies of the natural method.

Foreign Language as the Medium of Instruction

There is one other characteristic of the natural method which has from time to time reappeared in the later methods. It is insisted by advocates of the natural method that only the foreign language which is the subject of instruction shall be used by the teacher and by the student. The emphasis which is laid on the foreign language in this and other methods is a matter of psychological interest.

From the point of view of the use of the foreign language as an instrument for reading the literature of that language, there can be no doubt at all that the student should ultimately reach the stage which will make it unnecessary for him to translate each word into his own vernacular. Even those who lay great stress upon the translation method would undoubtedly recognize the advantage of this kind of acquisition of a foreign language. It might be argued that such a mastery of the foreign language is seldom attained in the schools, and consequently there will be many teachers who will feel justified in giving up from the outset any hope of attaining this desirable end. They will insist that the advantages of a translation knowledge are great enough to justify the teaching of a foreign language in the school curriculum, and that there is accordingly no need of insisting on the use of foreign words in instruction.

Translation as the Method of Instruction

The student of psychology finds himself in the position of accepting both views. If one can get a reading knowledge of the language, that is good; if one must translate, let him do so with diligence. The psychology of the two cases is different. Let us therefore take note of the statements made by the opposing parties.

The proper opinion among those who have not thought the matter over, or who have not given sufficiently careful attention to their own mental processes is that a foreign language can be understood only by transposing it into one's mother tongue; but this is not so. Those who read foreign authors in the original with real advantage do not actually first translate each word, still less each sentence or each period, into English before they proceed further.[1] (P. 48.)

Our ideal must rather be the nearest possible approach to the native's command of the language so that the words and sentences may waken the same idea in us as in the native — and these ideas, as we well know, are not the same as those called forth by the corresponding words in our own language. (P. 54.)

For all these reasons, it is not translation (or skill in translation) that we are aiming at in teaching foreign languages. (P. 55.)

Contrast with these statements by Jespersen the dictum of Lowell quoted by Bennett.[2]

In reading such books as chiefly deserve to be read in any foreign language, it is wise to translate consciously and in words as we read. There is no such help to a fuller mastery of our vernacular. It compels us to such a choosing, and testing, to so nice a discrimination of sound, propriety, position, and shade of meaning, that we now first learn the secret of the words we have been using or misusing all our lives, and are gradually made aware that to set forth even the plainest matter as it should be set forth is not only a very difficult thing, calling for thought and practice, but is an affair of conscience as well. Translation teaches, as nothing else can, not only that there is a best way, but that it is the only way. Those who have tried it know too well how easy it is to grasp the verbal meaning of a sentence or of a verse. That is the bird in the hand. The real meaning, the soul of it, that which makes it literature and not jargon, that is the bird in the bush, which tantalizes and

[1] O. Jespersen, How to Teach a Foreign Language. Allen & Co., 1912.

[2] Bennett and Bristol, The Teaching of Latin and Greek, p. 18. Longmans, Green, & Co., 1906.

stimulates with the vanishing glimpses we catch of it as it flits from one to another lurking-place:

> Et fugit ad salices et se cupit ante videri.

The psychologist has two comments to offer. First, the two kinds of mental processes sought by these two opposing views are radically different. Second, which is better in any given social situation depends on considerations that are not psychological. For example, if a student has just one year in which to get all the knowledge of German that he is going to get, the social situation is very different from that which confronts teacher and student when the latter expects to take German four years in succession. Those language teachers who oppose translation to direct knowledge of the foreign language should realize that both are psychologically possible, but that one or the other can be more advantageously sought under given conditions.

THE PSYCHOLOGICAL METHOD

The third method which is discussed in the Report of the Committee of Twelve is the so-called psychological method.[1] There are two distinct characteristics of this method: first, the word is learned in close association with the object to which it refers and much emphasis is laid on sensory experiences as giving words their value and meaning; second, all words are acquired as parts of short sentences, these sentences being at the outset of the study very simple, and gradually increasing in complexity until the student is able to read any miscellaneous text in the foreign language. The first contention of the method — that words should be associated with objects — is to be viewed most critically,

[1] For a full discussion of this method see articles by R. Kron in *Die neueren Sprachen*, Vol. III, 1896. For a discussion of the first characteristic, see especially p. 10; the second is also fully illustrated.

especially in the form in which it is commonly presented. The principle of sentence study and serial progression is in keeping with the best tendencies of recent educational methodology.

Imagery

In discussing the requirement of the psychological method, that objects or images be associated with words, the Committee of Twelve makes the following statement:

On presenting each new word to the beginner, the instructor exhorts him to close his eyes and form a distinct mental picture of the thing or act represented. This image (it is affirmed) will remain indissolubly connected with the word, and the evocation of the one will always recall the other. Sometimes real objects or drawings are used, and pantomime is frequently resorted to; but in most cases reliance is placed on the child's active imagination.

Direct Sensory and Motor Processes

One of the recent writers[1] says:

Another cardinal doctrine of the reformers is the belief that the more direct the connection established between the thing and its name, the more direct the association between an idea and its expression, the more permanent and effective it will be. . . . Pantomime, gesture, bodily movement, impressions made by concrete objects upon the various senses, all sorts of devices are employed to enable the instructor to dispense with the vernacular. (Pp. 476, 477.)

The use of *Realien* constitutes a valuable adjunct to this method of instruction. In addition to the well-known and widely used pictures of the seasons by Hoelzel, upon which conversation may be based, whatever tends to throw light upon the material and spiritual life of the nation whose language is being studied receives a hearty welcome. (Pp. 478, 479.)

[1] A. Gideon, The Phonetic Method of Teaching Foreign Languages, *School Review*, 1909, Vol. XVII, pp. 476–480.

In the latter part of this article the author argues that because brain physiology has shown that several different centers, especially those of hearing and vision, are involved in the cerebral processes connected with speech that it is desirable to arouse to action, in the course of language study, as many of these centers as possible.

A like discussion is to be found in an article published in *Science*.[1]

Physiological psychology teaches us that four distinct centers of the brain are active in the acquisition of language; namely: the auditory, the visual, the motor writing, and the motor speech centers, the first two sensory, the latter two motor. The function of the auditory center is to receive sensory impressions through the nerves of the ear; that of the visual center to receive impressions from the nerves of the eye; the motor-writing center controls the muscles of the hand in writing, while the motor speech center controls the muscles of the speech organs. . . .

Without going into the old question whether sensation is the sole principle of knowledge, we are on safe ground psychologically when we assert that in learning a language auditory, visual and kinesthetic sensations play the most important rôle, and are in fact the basis of knowledge. It follows then that the greater the number of sensory impressions that can be enlisted in the acquisition of language, the greater the acquisition. It follows also that the more combined the activity of the senses, the more rapid and the more thorough will be the organization of the speech centers physically and psychically. . . .

Thus the argument which is often used against the analytical or direct method that adults do not learn language like children do loses much of its force. Certain it is that for adults the idea comes before the sign for the idea, although, to be sure, the mature mind, accustomed to abstract thinking, soon demands that it be given not only the percepts but the concepts, and the general concepts as well.

Good pedagogy should call into activity all the powers of the mind of the learner. Thus in the case of the language

[1] April 18, 1913, Vol. XXXVII, p. 600.

teacher, to utilize the visual and the graphic centers only, and allow the auditory and the motor speech centers to lie barren, is to get only a portion of the sensory impression that may be got if all the centers are utilized.

Again, since some individuals of a group will learn better by the utilization of the visual and the graphic centers, others by the utilization of the auditory and the motor-speech centers, etc., every course in language should give opportunity for both forms of impression and both forms of expression, that is, for hearing, and seeing (reading); for speaking and writing.

Language study is best cultivated by utilizing the nervous energy of all four centers, that is, the ear, the eye, the vocal organs and the hand. Each must support the other, thus heightening the total impression.

Generalizations, in this case principles and laws, must base upon sense perceptions, in this case spoken or written words and phrases, and must follow, not precede them.

Finally, an example may be quoted from the notes taken at the conference at Sorbonne by Charles Schweitzer.[1]

Take, for example, the word "apple." In learning his native tongue the French child sees the fruit placed before him on the table or suspended from the tree. At the same time some one pronounces to him the word "apple" and accompanies the pronunciation of this word by a gesture. After the experience has been repeated several times an indissoluble association is formed between the two percepts, one a visual percept and the other an auditory percept. An equation is set up in the mind of the child between the word "apple" and the image of an apple. The two members of this equation form so intimate an association that the image of the object will invariably call up the word and that which the word was intended to introduce, namely, the image of the object.

[1] Methodologie des Langues Vivantes, p. 7. Librairie Armand Colin, 1903.

Criticism of "Imagery" and "Sensation" Doctrines

These quotations show how much emphasis the psychological method has laid upon the images which reproduce sensations and which all learners are supposed to form of objects when they begin to acquire the words of a language. Enough has been said in an earlier discussion of the nature of language to make it clear that this conception which lays stress upon the images associated with words is true only in a very limited way, if, indeed, it is true at all. Doubtless the mind does carry certain images of the objects for which we have names in mature life, but these images are very vague and very general. Let one test himself, for example, to see how exact and complete is his image related to any object which he may know by name. For example, suppose one hears the word "animal" or the word "vertebrate" and asks himself how fully these familiar words are paralleled in his experience by images that could be subjected to any careful analysis. If our adult images are vague and indefinite even in a field where popular science has done much to make ideas clear, it is much more the case that a child's images are vague and indefinite. One has only to observe a child in the early stages of his acquisition of language to realize the truth of this statement. He uses words in a broad, general way. For example, any sort of liquid will be called "water," not because the word calls up any definite idea of a particular substance but rather because all of the various substances are enough alike to fit into his loose, general imagery. In the same fashion, the word "horse" is not used by the child in any sharply defined way so as to distinguish one of the larger animals from the rest, which resemble it in gross outline; the child uses the word to refer to any large object, even applying it to his playthings which have no sensory likeness to the animal at all.

The evidence from the study of the child's vocabulary is reënforced by a study of his efforts to reproduce images. The moment he begins to draw he exhibits with perfect clearness the fact that his images are not sharp and definite; they are vague and symbolic — that is, a few irregular lines stand in his mind for some object such as man or animal, and there is no possibility, until his mental development has gone much further, of his refining these crude images so as to make them resemble at all closely the objects for which they stand in his thinking. The child's mental attitudes toward the world are dominated by his own personal feelings and by his own attitudes of reactions toward the world. He likes things or dislikes them with great intensity. He does not make any careful analysis of their form or external characteristics. What is true of his images is true of his words. These words are significant to him not because they are associated with the external characteristics of objects such as the form and color of these objects; they are significant rather because they call up in his experience certain attitudes of mind and body which he has learned to assume toward the objects which are being designated.

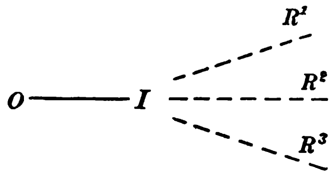
Reaction Essential to Interpretation

O ——— I ——— R

When, therefore, the psychological method of teaching foreign languages begins to lay great emphasis upon sensory aspects of language, it fails to include the most essential facts in the situation. Perhaps this can be made clear by the use of a series of simple diagrams. Let us represent an external object as it impresses the individual by the letter *O*. The letter *I* will be used to represent the individual who is brought in contact with this object. A line connecting *O* and *I* will represent the

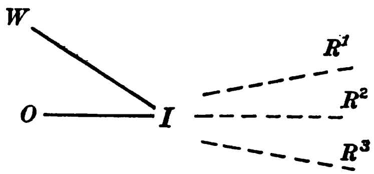
impression which is produced upon the individual by this external object. A line issuing from *I* in a direction opposite to that from which the impression came represents the reaction of the individual upon the object. This reaction may be an emotional reaction, as when an individual is afraid of the object which he sees; or it may be a reaction of the hand and arm, as when an individual seeks to grasp the object. In any case the reaction is an expression of the individual's organization rather than a matter of impression from the object.

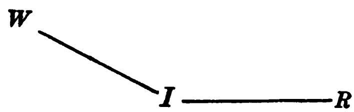
The little child gets an impression from the object, but this is by no means the important part of the whole situation from the psychological point of view. Much more significant is the reaction which issues from the child. At the outset these reactions on the part of the child are few in number and simple in character. As he develops, however, there come to be a great variety of them, among which are the reactions of the vocal cords. We can now represent the second stage of our psychological analysis by showing



that the impression received by the child may issue in a variety of different forms of reaction. These are represented by the three reaction lines that issue from *I*. These different types of reaction have more or less connection with each other. The result is that when an object calls for one form of reaction, it tends at the same time to call up other forms of reaction. Certain cross associations begin to set themselves up between the different types of reaction. This we might represent by drawing cross lines between the different *R*'s that were indicated in the second diagram. At the same time a new type of impression begins to act upon the individual. This is the auditory impression which comes to him from his own

reactions of articulation and from the words which are produced by those who are about him. We may set down, therefore, in the third diagram two incoming sensory impressions; namely, the original type of impression *O* and the new type of impression *W*. *W*, in turn, gets its meaning not merely by virtue of the fact that it is connected with *O*, but more from the fact that it is connected with the various forms of reaction which constitute the individual's reaction to *O*. Indeed, after *O* has led to the organization of R^1, R^2, and R^3, these may attach directly to *W*, as when one reacts to the cry of danger rather than to the sight of a dangerous object. The interpretation of a word is therefore an elaborate product of development, depending quite as much upon the *R*'s as upon *O*.





In their emphasis upon objects, the natural method and the psychological method lay great stress on the connection of the word with *O*, but they overlook the importance of all of the *R* elements which enter into the interpretation of words. From what has been said in an earlier chapter which deals with the nature of language, the absurdity of this overemphasis is apparent.

Many Words Incapable of Sensory Interpretation

Furthermore, one might derive from the study of words much evidence in support of the general psychological conclusion which was reached in the earlier chapter. One needs very little contact with the language to note that there

are many words for which it is quite impossible to have any images whatsoever. Prepositions, for example, and connective words obviously cannot have any imagery which could be made the basis of interpretation. All sorts of abstract words fall into the same class. It should be noted that there is no denial in all of this discussion of the presence or value of imagery in certain psychological conditions; but it should be reiterated here, as it was in the chapter on the nature of language, that very often, especially in the higher forms of experience, imagery is a hindrance rather than a support to thought. Words are superior to images for the higher thought-processes. They come to be substitutes for the images of objects; and it is distinctly uneconomical for a trained individual to attempt to carry in his mind any long train of images — it is much simpler for him to use words as actual substitutes for the objects, and to depend upon his trained reactions associated with these words to guide him in his thought, rather than to go back to the primitive forms of imagery out of which his interpretations may, in some cases, have originated.

Reactions refine Images

Furthermore, even when we study mental imagery it can be shown that reactions are more important than impressions in determining the character of the memory picture which we carry away from the objects about us. If we want to know the details of form in an object, we set ourselves the task of reproducing it in a drawing or by carefully tracing its outlines through reactions. Even the verbal reactions can be described as our most potent instruments for inducing and supporting analysis of images. Consider, for example, the fact that the botanist is able to train his students in the observation of plants through the development of a series of names of the different parts of the plant. When

a child looks at a plant, before he has had any scientific training whatsoever, he sees the characteristics only in a broad, general way. There is no practical motive for a discrimination of the different parts. There is no reaction to these different parts which would tend to distinguish one part from another. For purposes of scientific study a terminology is created which constitutes a kind of artificial reaction to the different parts of the object. The individual is now equipped with the motives and with the psychological devices to aid him in his discriminations. He reacts with one word to one part of the object, and with an entirely different word to another part of the plant, with the result that he recognizes the different parts of the plant and gives to each enough attention to distinguish it in the percept and in the memory from the other parts which are differently named. These sharp distinctions of science may later be used for practical purposes, but they are commonly cultivated as scientific distinctions before practical life takes them up and makes use of them. We shall have occasion later to call attention to the difference between the motives that grow out of verbal discriminations and the motives which appear in practical life for the analysis and discrimination of the parts of objects. For our present purposes it is enough, with the aid of this example, to have called attention to the fact that words and verbal reactions are among the important means employed in intellectual development for the analysis of impressions themselves. A body of impressions which has been thus analyzed through the use of discriminating words is a much more highly refined experience than any which presents itself to the mind before verbal reactions were developed. Furthermore, the introduction of the child to all those distinctions which society has found to be important is rendered easy through language. Words are therefore means of transmitting distinctions as well as means of establishing them.

Mature Discriminations depend on Words

We are now prepared for the final criticism of the so-called psychological method of teaching foreign languages. The most important characteristic of a mature mind is that its discriminations as well as its contents are determined in great measure by words. Words constitute the chief instruments of thought and of reaction upon all things. A man reacts with words to most of the situations of life. Even when he is thinking to himself he uses words. If a mature person tries now to acquire a foreign language, he cannot possibly go back to the supposedly primitive stage when impressions are the chief factors in building up mental life. Impressions, as a matter of fact, never were of great importance as compared with reactions, but certainly in mature life sensations sink far into the background. The so-called psychological method turns out to be quite unpsychological in the analyses of mental processes which it proposes.

The real difficulty here is like that which was discussed a few paragraphs above when dealing with the example of pronunciation as employed by the Committee of Twelve. The mature mind has a fixed system of verbal reactions; and the development of a new foreign system of reactions is difficult just in the degree that the foreign language involves forms of reaction not present in the vernacular.

Special Difficulties in teaching American Children

In this connection it is interesting to note that people who have in their vernacular a highly inflected and complex language can learn a simple language very much more readily than one who has as his native tongue such a simple language as English makes progress in the opposite direction.

Foreign Languages demand New Reactions

The acquisition of a foreign language for a mature mind is accordingly a process of fitting new word impressions and reactions into an established system of language reactions. The meaning of this statement can be made clear by considering the following facts. There are certain grammatical habits peculiar to every language. This difference can be illustrated by drawing attention to the fact that in Latin and German it is perfectly safe to place the object of a verb before the subject of the sentence. In both of these inflected languages the accusative case shows by its form that it is the object of a verb. In English, on the other hand, the student must give heed to the order of his words and is always dependent upon the order of the sentence for the discrimination between the subject and the object of the verb. One naturally comes, therefore, in the English sentences to a fixity of arrangement which is unknown to the Latin or German language. Not only so, but the forms of inversion within the subordinate clauses are matters of habit of thought which English-speaking people find it difficult to take on. When one transposes the verb in German, he has expressed a relationship which seems very natural in the thought of the German, but has to be laboriously acquired by an English-speaking person. These habits of syntax are undoubtedly important if one is to speak a language. They are of some significance if one is to understand a language.

Habits of syntax are eclipsed in importance by habits of interpretation induced through intimate contact with words. There is no exact synonym for many a foreign word. Our own language has developed certain shades of meaning, full appreciation of which can be cultivated only by paying close attention to all the different contexts in which English words appear. The foreign word, in like fashion, has

its own peculiar significance; and that peculiar significance will be learned only by seeing the word in its proper context in the foreign language. The most striking examples of this sort appear when one tries to understand the German attitude toward such exclamations as are very common in German colloquial speech but, when translated, constitute objectionable profanity in English. The German is constantly using the term *Gott* where the literal English translation would be offensive and inappropriate. On the other hand, the German uses only in extreme cases such a word as *Donnerwetter*. When we try to translate this exclamation into English it becomes a very inoffensive remark on the weather, but to the German mind it is a form of vulgar and offensive profanity. It is quite impossible to convey the meaning of these different exclamations by any direct translation from one language into another. In like manner, the reader of Latin comedies finds himself, in his efforts to translate Plautus and Terence, in exactly the same situation in which a student of modern French finds himself when he tries to translate the slang of French colloquial speech. One is justified in saying, in the presence of these striking examples, that a language can never be translated.

Again, take such cases as the following. The conception which the German has when he uses such a common verb as *machen* is wholly different from the notion which the Englishman has when he uses the literal translation "to make." Mark Twain has pointed out in his discussions of the German language this peculiarity of the Teutonic mind in connection with the general word *machen*. Perhaps we can find a suitable English parallel in the colloquial use of the word "thing." An ordinary American uses the word "thing" to refer to objects in the external world, social situations, mental processes, and experiences; in short, he uses it on all occasions when he wishes to get a word that shall refer back to any situation which has been described

in an earlier sentence. "I meant no such thing" is a good illustration of the general use of the term. Such an idiom as this is almost unintelligible to anyone in whose language the common word for "thing" holds closer to the substantive idea. The curious mistakes which one finds when foreigners try to use some of the most common idiomatic phrases can be understood when we recognize the fact that a foreign word, in its own context, has legitimate shades of meaning which cannot be translated into another tongue.

Meaning through Context

Such considerations as these are in the minds of language teachers when they emphasize the desirability of using only foreign words in the foreign-language class. The foreign word then gets its meaning from its setting, we are told, and the student is saved the confusion of trying to translate. The advantages and disadvantages of translation have been commented on above. It remains here to call attention to the fact that if the student cannot be thought of as beginning at the beginning when he meets a foreign word, the chances are great that he will fall back on one of his familiar vernacular reactions. As in the case of pronunciation, there is much to be said in favor of the method of conscious direction of the learner's efforts by contrasting foreign words with vernacular words. The mature high-school student can, if properly directed, make comparisons which will be productive. Why not give him some of the advantages of an analytical study of the foreign word in contrast with the vernacular?

Graded Exercises

The other alternative is to make a very gradual entrance into the language through a series of carefully prepared exercises. This was the second aim of the psychological

method. The method, as worked out especially by Gouin, gradually builds up a vocabulary by taking a few simple words and carrying the student step by step through combinations of these words and more elaborate combinations of simpler words to a final mastery of the foreign vocabulary. This gradual method of procedure gives the student a certain confidence and a certain ability to interpret the whole idea that is expressed in the sentence, as distinguished from the partial idea that comes from an isolated word. The psychological study of language has made it perfectly clear that the unit of all language consciousness is the sentence rather than the isolated word. A sentence conveys a fully rounded series of experiences. The psychological method undoubtedly does well to take advantage of the possibility of giving the student in foreign language, as well as in his vernacular, a whole sentence rather than a part of the sentence.

No elaborate argument needs to be presented in support of the effort which the psychological method has made to grade its sentences. If the sentences can be so worked out that the student can interpret the new words from the context, the interpretation will be exact in character and will, at the same time, serve to make the student independent in his later interpretations of new words and new sentences.

THE DIRECT METHOD

This method of gradually inducting the student into the language has also been called the direct method. Great enthusiasm has of late been expressed for the direct method both among teachers of modern languages and among teachers of classics. The following quotation from W. H. D. Rouse[1] illustrates how far some teachers are willing to go in praise of the direct method.

[1] Preface to "Decem Fabulae Pueris Puellisque Agendae." Clarendon Press, Oxford, 1912.

It is fortunately no longer needful to defend the direct method of teaching languages, no one whose opinion is based on knowledge now attacks it, so long as the languages to be taught are modern. But there was a time not so long ago, when the method was derided as foolish or slovenly by those who had not tried it; and this is the case now with the direct method of teaching Latin and Greek. Those who have tried it, so far as my knowledge goes, are quite at ease in their minds; they have found not only that it is quicker and more attractive, but that it does really what the exercise-book method pretends to do, that is, it holds the attention in detail, disciplines the mental faculties, and enables the scholars to understand and to appreciate the best qualities in the best literature. Of course, the direct method is not all talking; the system includes reading, writing, and even the conscious learning of grammar, although in different order and different proportion to that of the exercise books. But speech does take in it the first place.

The direct method has been vigorously discussed under a variety of titles in recent years. It is sometimes called the reform method; sometimes it is designated the analytical, inductive method. A full description of its details can be found in a pamphlet by Viëtor.[1] Sometimes the phonic element has been emphasized, as in the report of the Committee of Twelve.

Aim must control the Method of Instruction

We may concentrate attention on the one fundamental, psychological question which comes up everywhere. This fundamental, psychological problem can be stated in this

[1] Der Sprachunterricht muss umkehren! Ein Beitrag zur Ueberbürdungs-frage von Quousque Tandem. Heilbronn, Verlag der Gebrüder Henninger, 1882. A summary of this document is to be found in the *Teachers College Record* referred to on page 211, Vol. IV, No. 3, and also in the reprint "Teaching of Modern Languages," by Leopold Bahlsen (translated by M. B. Evans). Ginn and Company, 1905.

form: Should foreign languages be taught by a method which ignores, as far as possible, the acquired grammatical and verbal habits of the student, or should the contrast between the vernacular and the foreign language be consciously brought out and made an important part of the study?

The writer once saw an experiment in teaching which puts the issue in a clear light. He visited a school in a rural district where a clergyman had gathered together a few of the children of the community who had taken all that the district school could offer, and was attempting to give them some view of higher subjects. The teacher, who was himself trained in Latin and Greek, was utilizing a few Latin stories to teach the children something about the Roman language and the derivation of English words. This teacher was not attempting to give a Latin course. He had no grammar, and he had no desire to make the students acquainted with Latin literature through the reading of Latin texts. In fact, he had changed the pronunciation which he had himself cultivated in college, and was utilizing for purposes of training the children an English pronunciation, which helped them to recognize the direct relationship between the Latin roots and the familiar English words which are derived from these roots.

The Inductive Method

Another example which illustrates the issue is seen in an experiment which was undertaken a few years ago in the so-called inductive method. The method never proved a general success, probably because it sacrificed the language in order to give students principles about language. A brief review of the method will indicate how far it went in analytical studies of language.[1]

[1] Harper and Burgess, Inductive Latin Primer, Preface. American Book Company, 1891.

A sentence of the original text is placed before the pupil. The pronunciation and exact translation of each word are furnished him. By the aid which the teacher gives him in advance, and with the help given in the book, he thoroughly masters the words and phrases of this sentence. His knowledge is tested by requiring him to recite or write the Latin sentence, with only the translation before his eye.

In connection with this mastery of the words and phrases of the sentence assigned, the pupil reads and digests the contents of the "Notes" on these words. This study accomplishes two things: first, the careful examination of each remark, with its application to the work in hand, aids in fixing more firmly in mind the word sought to be mastered; second, grammatical material is being collected from the very beginning of his work.

The "Text" and "Notes" having been learned, the next step is one of a more general character. Out of the material which has thus far been mastered, those principles which are of most importance, and which the pupil himself will be most likely to recognize, are pointed out under the head of "Observations." The pupil should be brought to see these principles for himself before reading the statement of them in the "Observations."

The words of the sentence are now separated from their context and placed in alphabetical order. Thus separated, they form the basis of additional study.

In order to prevent the memorizing of the Latin text without a clear idea of the force of each word, to impress more firmly on the mind the words and phrases of the text, and to drill the pupil in prose composition — "Exercises," Latin into English and English into Latin are given. These are always based upon the sentence which furnishes the basis of the "Lesson."

Once more the leading points of the entire lesson, whether suggested in the "Notes," the "Observations," or the "Vocabulary," come up for consideration under the head of "Topics for Study." Upon each topic the student is expected to make a statement of what he knows (not of what has been said in the book). If his statement is not sufficiently full, it will be criticized by the class.

From this outline the idea of the method will be apparent. It proposes: first, to gain from the classic text an accurate knowledge of some of the facts of the language; second, to learn from these facts the principles which they illustrate, and by which they are regulated; third, to apply these principles in the further progress of the work.

This method is reported to have been most successful in the hands of skilled teachers in giving to mature students within the compass of a few exercises some knowledge of the language and much knowledge about the principles of construction and interpretation.

Special Ends served by Different Methods

Our psychological analysis makes it easy to understand the school situation as it confronts us to-day. Those who would teach students to master a language and have much time for instruction tend toward the direct method. Those who are interested in the scientific study of language emphasize analytical discussions and are skeptical of the direct method. Wherever mature students are involved, the direct method tends to give way to some form of analytical method. Analytical methods in one sphere, as, for example, in pronunciation, are at times combined with direct methods in other spheres, as, for example, in the interpretation of words. In the meantime, teachers of English-speaking children do not make as much headway with language instruction as do teachers of children familiar with a highly inflected language.

On the administrative side, pressure becomes more intense to reduce the amount of time given to language courses and to increase the value to the student of what he takes even if he remains in the course only one year.

Furthermore, there can be no doubt that we are confronted in America with a grave problem because we begin language work late, that is, in the high school or even in

the college. The methods appropriate to teaching children in their early years are radically different from those appropriate to maturer years. Just at what point the direct method should diminish and the analytical method increase is with us a most urgent problem, and, unfortunately, as yet an unsolved problem. While this problem is awaiting solution .we are all much in the position of the Committee of Twelve. We praise the direct method and follow the analytical method, with strong leanings toward the grammatical method.

General Language Course

There is one experiment which a psychologist may venture to suggest to teachers of language. Let a course be prepared that shall teach much about language structures through an analytical study of some foreign language. Let the student have an insight into the rich field of comparative philology and comparative study of civilization. Take some of the time now given uselessly to English composition if the foreign-language departments are unwilling to contribute the time for such a course. Let such a course be open to everyone who wants to know in a year what Latin and German are. When this course has been tried, note whether students do not begin language work of the present type more enthusiastically.

By way of practical administrative suggestion it may be legitimate to urge that some of the instructional energy which is being rapidly released in the classical departments be turned to the task of trying this experiment.

Finally, in order to make perfectly clear the psychological conclusion of the whole matter, let it be explicitly pointed out that there is no single best method of teaching foreign languages. The method must vary with the purpose and the maturity of students.

Class Observation

In this connection the writer may venture to add two observations made in the classroom. He has observed classes struggling to get a meaning of a foreign word, and confused beyond degree because of the teacher's dogmatic determination to use only the direct method; and he has been persuaded that it requires more than ordinary resourcefulness and more command of the language than most teachers possess to adhere at all times to the strictest form of the direct method. Second, like every other observer of language instruction, he has seen formal analysis carried to such limits that he has been almost persuaded to become a convert to the most extreme form of the direct method.

If one could gain the advantages of direct use of the language without losing the virtues of analysis, and could also get some of the quick returns of intelligent analytical study as a foundation for later, more intimate appreciation of words in their context, he would in a measure gain the advantages of both tendencies. If one must choose, his choice will certainly depend on general social conditions. Children in their early years gain little from analysis; adults gain much. Time is always a factor which must be considered. The consideration of these social factors suggests that probably there is truth in several different and apparently opposing statements about languages and language teaching. We may therefore close, as we began, with a plea for careful, discriminating, impersonal examination of all claims and methods rather than a partisan dogmatism in favor of any single solution of the matter.

CHAPTER XI

OPPOSITION BETWEEN THE PRACTICAL ARTS AND LANGUAGE

Thus far we have discussed the problems which relate to the teaching of mathematics and the language subjects. It would perhaps be most natural to continue the discussion by taking up those branches of school work which depend very largely upon the ability to use books, such as history and certain phases of science. Language is not merely a subject of instruction in itself, it is also a tool employed in the study of other subjects. But the psychological problems which confront us in teaching any subject which depends upon the use of books can be clearly understood only when we contrast with book subjects those which depend upon the cultivation of practical, manual skill.

Rise of New Subjects of Instruction

There is at the present time a growing tendency in the secondary course to recognize the importance of various kinds of training which are wholly at variance, so far as their content and form are concerned, with the academic traditions of earlier years. One finds in the technical high school of to-day an equipment for shop work and laboratory work that is altogether foreign to the conception of education which was common in the high school of a generation ago. Agriculture has taken a major place in those high schools which are situated in rural communities. Much of the work of the agricultural high schools is carried on in

the field in a fashion utterly unfamiliar to the high-school teacher at the close of the last century.

The introduction of these new subjects has been hastened by the demand of the industries that more attention be given to the preparation of expert laborers. The problem of providing for boys from fourteen to sixteen years of age is one of the clearly recognized and conspicuous problems of present-day social life. While the urgency of the situation is somewhat less for girls, there is nevertheless a clear recognition of the fact that some kind of training must be devised for girls who are not going to take the ordinary high-school course.

We turn away, then, from the discussion of language and all that belongs to the language subjects, for the purpose of gaining a clearer notion of the mental processes which attach to these newer subjects. We shall then be able to return to the analysis of science and history with a better preparation for the appreciation of their place in the course of study.

Manual Training and Industrial Courses

The first break in the curriculum which carried the schools away from the purely academic traditions of an earlier day was in the direction of the kind of training specifically known as manual training. In America the Centennial Exposition in Philadelphia was undoubtedly important in bringing the attention of American educators to the value of this sort of instruction for school children. For a number of years great enthusiasm was exhibited at certain centers. Very shortly, however, objections presented themselves. Where the manual-training courses followed rigidly one of the set systems, these courses were criticized as formal and destructive to initiative. On the other hand, when no system was followed, the courses were criticized as loose and unsystematic. In recent years it has become the fashion in

some quarters to attack manual training as a wholly unsuccessful experiment. It is said to be neither academic nor practical. Industrial training is urged as the true method of giving skill of hand and equipment for real life. Furthermore, there are general social forces pushing in the direction of industrial education. So it comes that as we hear less of manual training we hear more of industrial arts. There can be no doubt that the technical industrial arts are at the present moment very much respected by modern society and by those school officers who wish to keep the curriculum abreast with the demands of modern life.

Our discussion naturally follows both of these lines of development. We may with propriety introduce the whole discussion by considering the psychological claims of manual training in its most general form. We shall not concern ourselves in this general discussion with any of the minor disputes which have arisen within the camp of technical teachers themselves. We shall use the term "manual training" to include any of the forms of manual work which have been developed in recent years in the general, untechnical, nonindustrial courses of study. We shall then take up briefly the mental processes which are developed in the course of the cultivation of some of the industrial arts.

It may be well to point out, before entering upon the details of these various discussions, that it is not in place here to canvass all of the considerations that arise in connection with these different subjects. Our business is merely to make a psychological analysis of these different forms of training. The social conditions which call for more or less emphasis on one or the other of the practical forms of training we cannot with propriety take up. We shall have occasion repeatedly to refer to the fact that the strictly educational questions which arise in the effort to introduce these subjects into the course of study are very much complicated by social conditions. For example, there is the fact

that specialists in the technical arts have felt themselves for a long time separated from the rest of the teaching profession by a prejudice against the manual arts. As one of the chief exponents of these arts has pointed out:[1]

WOODWARD ON THE DIFFICULTIES OF INTRODUCING MANUAL TRAINING

The traditions are heavily against us, but the traditions of the fathers must yield to the new dispensation. As was to have been expected, the strongest prejudices against this reform exist in old educational centers. . . . The idea of giving heed to the demands of skilled labor, of preparing for lives of activity and usefulness; the idea of earning one's daily bread and of supporting one's family — scarcely enters their heads. . . . In such an atmosphere as that, how incongruous is the appeal of minds for an education to things; for a training of the hand and eye as well as the intellect to lives of useful employment! . . . The highly cultivated would soar away into purer air and nobler spheres. There is a feeling, more or less clearly expressed, that the material world is gross and unrefined; that soiled hands are a reproach; that the garb of a mechanic necessarily clothes a person of sordid tastes and low desires.

There can be no denying that this sort of prejudice exists in many quarters. To be sure, it is breaking down very rapidly. Again and again, however, one must listen to the charge made by one's own colleagues in the educational profession that the educational world is not only prejudiced against the practical arts, but is wholly unable to sympathize with their introduction into the school. In a recent discussion the Commissioner of Education[2] of the State of Massachusetts made the following statements:

[1] C. M. Woodward, The Manual Training School, pp. 190 ff. D. C. Heath & Co., 1887.

[2] David Snedden, "Summation," *Bulletin No. 18*, Proceedings of the Seventh Annual Meeting of the National Society for the Promotion of Industrial Education, pp. 55, 57. Manual Arts Press, Peoria, Illinois, 1914.

SNEDDEN ON VOCATIONAL COURSES

Ancient division exists between so-called cultural education and the practical affairs of life. The schoolmaster has kept his pupils as long as possible from submergence in utilitarian activities. He has often had a contempt for the manual occupations. He has looked with favor upon professional callings and others involving the maximum of intellectual activity. On the other hand, the practical man has always looked upon the schoolmaster as somewhat over-refined, effeminate and impractical, with a disposition to follow visions. . . .

With reference to these issues, my experience has been that the inherited antagonism between cultural and vocational education has by no means disappeared, and that to an extent as yet unrealized the educator not only holds to traditional views, but is constitutionally unable in many cases to alter his attitude. It seems to me that the educational literature of this country contains as yet surprisingly few statements regarding either the desirability or the feasibility of vocational education that exhibits the educator as a profound student of this subject. . . . Undoubtedly predisposed desires are in the direction of a purely intellectual approach to problems of skill as well as those of understanding.

Psychological Study an Antidote for Disagreement

Even more vigorous comments upon the situation than those which have just been quoted can be found in current educational literature, but for our purposes it is enough to call attention to the fact that other than strictly psychological considerations are operated in determining the entrance of practical courses into the curriculum of the high school. Needless to say, the psychologist has no sympathy with any of these prejudices. His one problem — as in the discussion of the various methods of teaching language — is to discover, if possible, the essential character of the mental processes which are aroused by the practical arts.

CHAPTER XII

MANUAL SKILL; PRACTICAL AND THEORETICAL EXPERIENCE

The Psychology of Skill

The psychology of skill is a chapter in the psychology of habit. We have come to realize in studies of animal and human behavior the importance of habit. The nervous system of the child is, at the beginning of life, a mass of unrealized possibilities. A visual stimulus entering the brain of an infant may come out in the form of a cry of surprise or fear; the hand may move in the effort to grasp the bright object from which the visual stimulus came; there may be a movement of the head; or the child may begin to turn away with his whole body. Out of this mass of possibilities comes, in the course of life, a series of regular modes of response. The nervous system, which was characterized at first by unlimited possibilities of varying response, is organized into a series of regular channels of response for each familiar stimulus. Such an organization of the nervous system has disadvantages as well as advantages. The man of fifty cannot adjust himself to new situations as can the child, because the nervous system of the mature man has been mapped out for better or for worse into a system of paths. The adult has his habits all formed. If these habits are of such a type that they carry him through life comfortably and successfully, well and good; if his habits are such that he continually does the wrong thing, he must suffer. The one major fact is that the nervous system has been laid out into a series of paths, and the habits of life are formed.

Among the habits cultivated in this transition from infancy to maturity are those which we group together under the general term "skill." One shows skill when he plays tennis, when he saws a board or drives a nail. A girl shows skill when she threads a needle or beats an egg. The artisan shows skill when he feeds a machine or sorts out its products. In all these cases the nervous system has been organized so that the stimulus which comes into the eye or the finger passes quickly and surely to the hand and arouses an act which through long repetition has come to have a degree of precision comparable to a mechanical process.

Characteristic Lack of Analysis

If we look into consciousness during the performance of an act which has developed into a habit we shall find as one of its most conspicuous characteristics an absence of all analysis. The consciousness which one has when he hits a tennis ball or a nail is a total, undivided experience of the whole situation. We sometimes speak of this experience as a feeling. One has a feeling that he has done the act well or badly, but he cannot tell either how he did it or how the successive steps of the processes took place. We sometimes describe the situation by saying that one does the act without any consciousness at all. Thus we say that we write without any consciousness of pencil and paper or the form of letters. We say that the carpenter adjusts his plane to the grain of the wood without thinking. Obviously such descriptive phrases are not to be taken literally. The person who is writing would be very promptly aware of the fact if his efforts produced no marks. This is evidence enough that he is not unconscious of paper and pencil and black lines. The carpenter knows when his plane is properly driven and he gets satisfaction out of the shaving which he produces. There is always consciousness accompanying

an habitual act, but it is not analytical consciousness. One does not think of details; one sees the situation as a whole. If questions are asked referring to some particular part of the situation, the reactor is at a loss to disentangle this part of the situation from the whole.

For the sake of a scientific study of habit the psychologist must make an analysis which the reactor himself does not make. Let us consider, therefore, the factors of a habit, taking our stand outside of the reactor and looking at him for the moment not as a conscious being but as a complex machine. Later we shall come back to a consideration of the inner, conscious characteristics of this same individual.

Sensory "Controls" in Handwriting

Since writing is one of the most common types of skill with which the school has to deal, and since it has been scientifically analyzed, let us note some of the elements of the writing process. We are guided in our formation of letters in large measure by the sensations of pressure[1] which come to us through the fingers which hold the pen. Especially is this true with regard to the height of letters. Let anyone try to make his letters twice as high as usual and he will at once become aware of the fact that the relations of pencil and paper are such that the pencil at the top of the letter tends to leave the paper. The old-fashioned shading of letters showed the same fact in another way. No heavy shading was made by upward strokes, because mechanically the pen rises from the paper in upward strokes. The downward strokes were the heavy strokes, because here the pen came with increasing pressure into contact with the paper. The changes in pressure which thus control the height of our letters are not ordinarily recognized by the writer.

[1] F. N. Freeman in Monograph Supplement No. 34 of the *Psychological Review*, 1907, p. 301.

Little children are more dependent than are adults on intense experiences of pressure. They break the points of pen and pencil because they press too hard in trying to secure intense sensations. The pressure sensations help them and help the adult in guiding movement. We speak of these sensations, therefore, as "controls" of writing, because as soon as the pressure at the top of a letter gets light the skillful writer is controlled in his movement and turns back. In like manner he is controlled at the bottom of his letter by the increasing pressure.

Tactual Controls in the Use of Tools

Every habitual act is governed by certain sensory controls. Each tool in the manual-training shop has its particular system of controls. Take, for example, the saw. When one drives the saw forward, it should engage the wood vigorously, just as the pen makes naturally a heavy downward stroke. When the saw is drawn back it should pass lightly over the wood. The skillful sawyer makes his movements without stopping to analyze the experience. The learner, on the other hand, has to pay close attention in order to acquire the proper adjustment of movements and sensations. Furthermore, the expert sawyer is instantly responsive to the sensations which come from his saw if the line which he is following is not perfectly straight. Let the saw swerve ever so little and the skillful workman makes the necessary turn of his hand. He knows, further, how to adjust his stroke to different kinds of material; and he knows also that when the board is just about divided he must make a skillful stroke in completing the cut which the novice does not know how to accomplish.

Contrast with the experiences which control the use of the saw those which control the use of the hammer. The workman very frequently gets indispensable aid in

controlling the hammer, which is swung with the right hand, by grasping with the left hand the nail which is to be driven. The guidance of the hammer depends further on the sensations received from the handle. These in turn are determined by the balance of the head on the handle, by the length of the handle, and by the way in which the hand grasps the handle. Each of these elements of the situation contributes to the experiences of pressure which the workman gets in the palm of his hand from the handle. Each stroke that he makes is guided by his sensations. But he does not analyze the situation into these elements. He thinks of it as a whole. He becomes accustomed to his hammer. He regards it as a misfortune when he breaks the handle, because the nice stroke is controlled by the familiar relation of the tool to his arm movement. Furthermore, the stroke itself is a complex series of adjustments. The skillful workman lets the hammer bear the shock of the stroke by relaxing the hand somewhat just at the instant of impact. The novice takes the stroke in his hand because he grasps the handle tightly. Finally, there is the precision of the stroke. The novice moves irregularly, now in one downward line and now in another. The skillful workman gauges his movements from the first movement, which is often a movement away from the nail to be hit, and thereafter swings the hammer with unerring precision in the same arc. The sensory surfaces of the workman's joints are involved during movement and supplement the skin of the hand in reporting to him the slightest deviation from the true course. He has complete sensory control of the swing, but he does not distinguish the separate sensory controls.

The foregoing analysis of tools will perhaps be clearer if we suggest the possibility of grouping together such tools as the knife, the saw, and the plane. All are cutting instruments and have the same general type of drive forward

and relaxed withdrawal. All must govern the intensity of the stroke by the texture of the material. All have secondary adjustments which are necessary if the stroke is to be kept straight. The control of these cutting tools is of a wholly different type from that of the driving tool. Furthermore, certain complex adjustments appear in the different methods of using the same tool. Is a chisel a cutting or a driving instrument? The answer to such a question leads us into the discussion of the chisel driven by the hand as different in its uses from the chisel driven by the hammer.

The psychology of the workshop could be indefinitely extended. We have a psychology of play; why not a psychology of the industrial arts? The delicacy of control exhibited in holding a billiard cue or in sinking a golf ball has perhaps been more fully discussed than the corresponding facts in the lives of artisans, because the player has more leisure and more social incentives for analysis than has the workman.

Visual Controls

Up to this point the sensory controls which have been discussed are those which come through the sense of touch. Another and even more elaborate discussion might be undertaken of visual controls in sawing and hammering. Rather than duplicate the description which has been given of touch sensations, however, we shall leave to the reader the description of the visual controls and shall turn directly to the important fact that in many cases vision, in spite of its general superiority, is not as useful a control for delicate movements as is touch. For example, the skill which the piano player acquires through a tactual recognition of the position of the fingers transcends visual control. In like fashion the skill of the carpenter who can saw a straight line by keeping his saw straight is much greater than that

of the novice who must look at the line and follow the seen line with his tool. In typewriting, the "touch" method is more rapid and exact than the mixed method, in which vision plays a part.

Other Sensations

Another contrast which has been suggested, and is of importance, is the contrast between sensations which come from the joints and inner organs and those which come from the ends of the fingers and skin. The typewriter who knows just how far to move from one key to the next and the piano player who takes three notes at one stroke by the nicest spatial adjustment of his fingers are not controlled by the skin sensations which come from their contact with the keys, but by the sensations from the joints and muscles of the fingers and hand.

Absence of Analysis

This discussion of the sensory controls which are present in all habits leads us to a very interesting psychological problem. Why does the person who uses all these sensory controls fail to recognize them? The answer to this question has already been suggested. Consciousness is not ordinarily sufficiently analytic to make the reactor aware of all the details. The reactor's consciousness deals with situations in the gross. Even when one begins to be analytic in his thought he is not likely to select as his object of attention the particular sensation which guides him in action.

Let us consider the rise of any particular habit; take, for example, the bicycle-riding habit. When one first gets on a bicycle, there is a great mass of sensations and a vivid consciousness of striving. This massive experience is soon supplemented by more experience arising from contact with

the ground and the necessity of disentangling one's self from the capsized object of attention. Little by little one gets so that he can pick out from this mass of experience the handlebars and the road ahead. As long as he holds tightly to the one and keeps his eyes fixedly on the other, matters seem to improve. The tight gripping of the handlebars gives the learner warning, through the sense of touch, of the slightest turning of the wheel, and thus one comes to avoid disaster by responding to these early danger signals. The eyes fixed on the path notify one of a change in relation of the body to the plumb-line and also deviations from the safe line of progress. The learner's consciousness will not exhibit all the facts with equal distinctness. He will see in the center and focus of consciousness the road, and then more road. The rest of the content of consciousness will be a vast, unanalyzed mass of what we call, for want of a better term, "feeling." This so-called feeling is not pleasure or displeasure; it is strain and tension. The rider is stretching every nerve, and is full of experience but not of detailed knowledge of his acts. A week later the paths in the nervous system will be organized so that the movements are satisfactory, but there will be no knowledge on the learner's part of the details of his adjustments. The intimations of loss of equilibrium which come through hand and eye now set up corrective movements without delay and without fail. The road has expanded into the countryside, and our rider thinks about the landscape. The content of his consciousness is what he sees; and all the feelings of bodily adjustment combine as a vague, undifferentiated margin of experience. Unless some new motive arises, he will never bring into the focus of thought the sensations of pressure from the handlebars and sensations of bodily movement which come from his efforts to maintain equilibrium. He has achieved a result without studying the process of his achievement. The details of how he

reached the result he does not know, for they were in his mind only a vague, massive feeling. The more perfect his adjustment the less motive there is to analyze the situation.

Analysis superimposed on Habit

One motive which might lead a bicycle rider to analyze his experience would be the necessity of teaching someone else. The analysis in this case would be greatly aided by the fact that one could watch in his pupil each stage of adjustment from the outsider's point of view. The expert rider sees the learner tipping and trying to recover by a sudden jerk. This is the wrong way to act. What is the right way? Now the expert realizes that he moves the front wheel in the direction in which he feels the bicycle tipping, so as to increase the breadth of his supporting base, and gradually recovers equilibrium by a slow movement. The whole process is thus reviewed analytically by first being looked at from the outside. The result in the mind of one who has made such an analysis is a curious mixture of images of someone else, images of one's self as though looked at from the outside, and sensations of tipping and movements of recovery.

Another good illustration of the analytical process necessary to understand one's skill appears when one tries to teach someone to hold his hands as he should to perform some manual trick involving both the right and left hands. One can move his own hands in the proper succession, but he is so confused by trying to guide the other person's hands in a relation which always presents itself in vision in the reverse that analysis is almost impossible.

It will be recognized from the examples which have been discussed that analysis does not naturally arise in the course of ordinary experience. One must get a new point of view if he is to make an analysis. If he does not deliberately

place himself outside of the ordinary experience, he will tend to think only of the outlying circumstances. The most striking evidences of this are the mistakes which people make in regard to their performances. Thus the untrained workman is likely to think the wood is hard rather than to recognize that his tool is dull. The tired bicycle rider thinks something is wrong with his wheel because it is so hard to move his legs. In both these cases the analyses are wrong because they are guided by accidental prejudices. Consciousness is thus seen to be, in many cases, an unsafe guide in the description of a habit. The habit may depend on certain complexes of sensation and may operate under the guidance of these sensations, while analyses, prompted by other motives, may follow other and often unsafe lines.

Advantages of Analysis

On the other hand, it is perfectly clear from the foregoing discussion that personal habits furnish unlimited opportunities for the exercise of analysis. One may substitute for the accidental and often incorrect analysis of ordinary life true and well-directed analysis of a scientific type, provided he directs his attention to the experience as a real problem. Thus the boy who makes a careful study of the construction of his tool before he begins to use it will have his attention turned inward to his direct experiences more than does the ordinary individual. Note how the teeth of a saw are set; which way ought it to cut? Note that one side of a chisel is beveled and the other is straight. Note that one may take hold of a hammer near the head or far away. Each of the analyses will help a novice, especially if the teacher has worked out clearly in his own experience the meaning of the adjustments. The analysis makes a student especially sensitive to certain impressions which will guide him in his activities. Thus,

following the example suggested a moment ago, if the student realizes that one side of a chisel has a different function from the other side, he will be prepared to take advantage of the sensations which come to him during the use of the tool. If he did not make the preliminary analysis, he would receive from the total situation a mass of impressions, and this mass of impressions would gradually work itself out into some degree of skill without any analysis.

Education and Analysis

Analysis is a different kind of mental process from direct, habitual contact. Consider the beginner who has made an analysis of his tool and observed his material. In the first place, his analysis usually employs a different set of sensations from those which control his acts. He uses his eye in making his analysis. His sense of touch is the one which is called into play during direct action.

The union of preliminary analysis and practical adjustment is accordingly a larger experience than practical activity taken by itself or visual analysis taken by itself. This larger experience, which includes the practical contact with the object and also the preliminary analysis, has certain advantages over either practical adjustment alone or analysis alone. A person who has made a visual analysis appears at times to be in a position to concentrate attention upon the various aspects of the tool experience which he would not have noticed if he had not made the analysis. This leads at times to precision of adjustment. At other times the effort to analyze the situation seems to cause distraction; that is, if one tries to keep in mind all of the elements of his complex experience, he may find that he is distracted by the effort to include so much in his consciousness. It is frequently pointed out by practical teachers that one must not be self-conscious during the performance of the act itself.

He must concentrate his whole attention upon the object with which he is dealing. If he tries to think of his own hand, and his own relation to the tool, and the relation of the tool to the material, he may get into so elaborate a state of consciousness that he will embarrass himself and be hindered in what would otherwise be a relatively simple and straightforward performance.

The relating of practical experience and analysis, therefore, constitutes one of the important problems of educational courses in the manual arts. The child in the workshop must not be self-conscious about his acts to the extent of interfering with his work. Some practical teachers are so impressed with this danger of distraction that they prefer to omit all possible reference to the analyses that seem to them to be too theoretical and remote. On the other hand, it must be recognized in many cases that while progress is slower under these distracting conditions of analysis, the ultimate achievement of the highest skill is promoted and the efficiency of the worker increased. When there is no analysis, habits of action are likely to become fixed early in the individual's training. On the other hand, where one has studied the relation between the tool and the material he is open to all sorts of suggestions for change in method, and these suggestions of change constitute in later experience a very great advantage, because after one has mastered the total complex situation and has learned how to use the tool, and has at the same time learned how to think about its use, he will have a very productive line of comparison opened up before him. He will distinguish between his own successful and unsuccessful acts and will note what are the elements of highest success. He will know how to borrow from other workers, for he will know how to watch them. In short, his whole activity will be raised to a high level of comparative study.

Analysis necessary in Progressive Behavior

There are two types of practical workmen in every trade. The one type of workman has acquired practical skill and has never thought about the way in which his skill was acquired, nor has he thought about the reasons why he is skillful. He works in a routine fashion, his activities becoming more and more solidified in the direction in which he started by accident at the beginning of his training. His methods become more and more fixed, and the whole attitude of mind comes to be that of an unquestioning worker, relying absolutely on the habits and controls which he has always used. The other class of workmen will always be looking for possible improvements in method, and they will succeed in introducing innovations in their own modes of activity which will be economical, or at least will be tested with reference to their economy. They look upon every situation as an object of interest and as an object of study. This group of men will find in the practical arts an opportunity for continuous mental development.

This last remark brings us to one of the crucial difficulties in the organization of practical work as a part of the school curriculum. If one goes into the manual-training shop and cultivates certain habits of adjustment, but makes no analysis of the situations in which he works, the progress of his course of study will be entirely different in this shop work from his progress in any other field, because shop work which is done without any analysis requires less and less attention to the act itself. We express this fact by saying that a habit requires less and less concentration as it becomes more fixed. The second course in manual training to such a student is not likely to be any more instructive than was the first. Indeed, we may describe the situation as it frequently appears in manual-training shops by saying that there is no progressive enlargement of the scope of work

in successive courses. The student might just as well have done the problems which he encounters in the second and third year during his first year of work. He becomes merely a more fixed and established artisan without becoming more intelligent. There is no intellectual progress involved in the training. On the other hand, academic courses usually show a very distinct line of increase of breadth and scope of interest. As one goes forward in a course in arithmetic to a course in algebra, he comes on new topics and new interests. If he can be shown the connection between these newer interests and the older interests with which he has been working, he will himself be distinctly aware of the intellectual progress of the work from stage to stage. In the same way, as one studies a foreign language he becomes increasingly conscious of the wider vocabulary which he accumulates and of the richer mental content which comes to him through the new books which he is able to read. Progression within the course is one of the greatest advantages that the older and more highly organized subjects present in the course of study. If manual training cannot in some way secure the same type of progressive interest, it will never commend itself as a school subject. This criticism of manual training cannot be met by simply enlarging the type of product which the student makes in the later years of his course. One finds at the present time that students in the second year are supposed to be stimulated to continue their work with enthusiasm and interest merely because they are making something large or because their interests are turned to considerations outside the work itself, such as the idea of making something useful in the home or in the school. Such interest is foreign to the training which the course is supposed to give; and unless the course itself can devise some means of keeping alive the intellectual interests of the students, there is no probability that an external motive will save it from formalism.

Educational Value of Manual Arts

The lack of clearness among teachers regarding the purpose of manual training, and regarding the best form which this work may take on, is reflected in a controversy which has long been going on about the place of manual work in the schools. One party of teachers is in favor of the general introduction of manual training into all schools, on the ground that there is a unique type of education which can be derived from such a course.[1]

These educators are anxious to have every child in the school required to take such a course. They say that it is well even for the boy who is to go into one of the professions that he shall get into the shop and learn the use of tools. Sometimes they justify this position in detail by saying that he will get a kind of experience in the shop which he does not get elsewhere. He will learn how to use his hands, and he will get a direct contact with nature which he can acquire through no other means. Again, they sometimes put the matter in the form of an argument in favor of social experience.[2] They say that it is well for the boy who is going into a profession to have the same kind of experience that is had by the workers who deal with material things. Such a boy will have a larger appreciation of the functions in society of the mason and the stoneworker. He will have a larger interest in the manufacturing processes with which he will come into indirect, social contact.

This group of teachers who are strongly in favor of courses in manual training is opposed by two groups of critics. The first group say that manual training does not cultivate a high degree of skill. The conditions of work in

[1] A. McArthur, Education in its Relation to Manual Industry. D. Appleton and Company, 1895. See also C. M. Woodward, Manual Training in Education. Charles Scribner's Sons, 1898.

[2] G. Kerschensteiner, Education for Citizenship. Rand McNally & Company, 1911.

the schools are not enough like conditions of work in the shop. There is too much spreading of the worker's energy over loose, general activities. Let us give up manual training and have trade training.[1] Trade training will be like real shop work. Get a good workman and put him in charge. Let skill be cultivated in the well-known fashion in which apprentices have always learned.

The other group of critics are those who say there is not enough training of the mind in a shop course. There is nothing to make a boy think, and nothing on which he can be examined when the work is done.

The problems suggested by these various contentions regarding handwork in the schools never called more urgently for solution than in this day and age, when technical schools are increasing in number and the demand for skilled labor is being vigorously set forth by practical men in the business world.

THE REACTION OF MANUAL ARTS ON THE INDIVIDUAL

We may note again that there are problems suggested in these discussions which go beyond the technical courses themselves and relate to the influence of the technical arts on the whole life and thought of the student. How far does the acquisition of skill make the student more appreciative of industry? How far does the mastery of a trade prepare one to think out new problems of a practical or theoretical type? Conversely, how far should the school attempt to maintain its traditional program, and how far should it give up language subjects for the practical subjects?

Some of these questions can be stated in a concrete form. Here is a boy who has made a table in the manual-training shop. He knows how difficult it is to fit together the parts.

[1] David Snedden, The Problem of Vocational Education, pp. 43 ff. Houghton Mifflin Company (Riverside Educational Monograph), 1910.

Will he ever look at a table again without considering how well or how badly it is put together? Here is a girl who has learned to sew. Will she ever lose her critical insight into the quality of workmanship exhibited in a garment? Evidently practical skill is accompanied by the cultivation of insights which are difficult to acquire unless one has actually constructed a typical thing.

We are told also that shop work is very helpful in the training of students because each piece of work requires a fidelity to the materials used which is more rigid than the fidelity required in merely reciting a verbal recitation to a class teacher. One may give an ambiguous answer, but he cannot drive an ambiguous nail. This demand for strict conformity to natural law is said to be very good for students.

Efficiency depends on Adequacy of Instruction

The striking fact, when all these claims have been recorded, is that manual training has sometimes failed to justify itself as a school subject, while in other cases it has served a most useful purpose. Here, as in other subjects, it is evidently no inherent characteristic of the course itself which brings advantage to the student; advantage appears or fails to appear because of the mental processes which the student cultivates during the course.

Our problem, therefore, is not to accept any general statement about the virtues or defects of manual arts, but to study their mental relations.

Experiments on Relation of Theory and Practice

On one aspect of this subject we have much evidence of a definite type to which we now turn. We have experimental studies which show certain of the relations between theory and practical behavior. In such a study it is easily

possible to set up a situation in which some practical activity can be definitely measured. Into this practical situation we then inject theory at a time and under conditions which make it possible to measure the practical activity again and discover whether the injection of theory has aided or hindered in the perfection of the activity. Such an experimental situation as this was set up by requiring two groups of boys in the fifth and six grades to hit a target under water. To do this, when the target is looked at obliquely from above, is a task requiring some readjustment of the boy's ordinary habit of throwing a dart, because the light which comes from the target is refracted as it leaves the water and, as a result, there is an apparent displacement of the target. Furthermore, the amount of apparent displacement will differ when the depth of the water is changed.

The two groups of boys selected for the experiment were made as nearly alike as possible by including in each group some boys who were described by the teachers as bright, some who were described by the teacher as slow, and a number of mediocres. Such educational experiment should always be tried on groups, otherwise results will be obscured by marked individual differences. The two groups were kept entirely apart from each other so that there was no possibility of a disturbance entering into the experiments through conference between the two groups. The one group was allowed to acquire experience without any instruction whatsoever. They were simply set at the task of hitting the target. The second group was given a preliminary explanation of what is meant by refraction and how the apparent displacement of the target is produced. The explanation thus given to the second group constituted the only distinguishing characteristic between the two groups. It may therefore be said that one group had the theory of the situation, while the other had no theoretical training.

Theory no Substitute for Practice

The result showed that the two groups of boys required the same length of time to learn how to hit the target under water. This first result of the experiment shows with perfect clearness that one cannot substitute theory for practical experience. One can know something about refraction, but if he has to deal with it he must learn to make his readjustments to the practical situation by actual readjustment of his movements, and this actual readjustment of his movements apparently will take place at a no more rapid rate than it does for any intelligent person who starts out to accomplish the practical task. In terms of our earlier discussion it may be said that the theory of refraction had to do with the visual part of the total experience. An analysis of the visual facts could not be carried over directly into hand movement, hence the time required in making the hand adjustment was not produced through a preliminary analysis of the visual facts.

Theory facilitates Adaptation to New Conditions

After both groups of boys had thus mastered the practical situation the experiment was modified by changing the depth of water. This change in the depth of water is followed, of course, by a change in the apparent displacement of the target. This change in the apparent displacement of the target turned out to be a source of very great confusion to the boys who had had no theoretical training. They had learned how to deal with one situation in which the target was under water, and they had at the outset of the experiment such natural experiences as any boy brings to a task of this type, but the new situation produced by changing the depth of the water did not correspond to either of these sets of experiences which they had mastered. They

consequently oscillated between the newly acquired experience with the first depth of water and the earlier, natural experience, which had nothing to do with water at all. They were doubly confused in their efforts to master the new situation.

The psychology of this confusion is the same as that which is often exhibited in practical life. Many men who are called upon to face a new practical situation are confused because of their earlier training and because of their fixed, unanalyzed modes of behavior. It is a well-known fact in the trades that men who have long been accustomed to one method of operation are very much confused by the introduction of new methods, such as new machinery or a new type of material. Their very training prevents them from exhibiting the kind of flexibility that would be presented by a novice unacquainted with earlier methods of adjustment.

As contrasted with these boys who had no theoretical training, the group of boys who knew the theory of refraction presented an entirely different result. These boys who knew the theory of the situation adapted themselves rapidly to the new depth of water. Their ability to deal with the new situation grew out of the fact that this new situation was recognized, because of the theory which they studied, in its true relation to their earlier experiences. The theory had put all their experiences — those without water, those with the earlier depth, and finally those with the new depth — in a single scheme of thought. They were aware of the fact that there are gradations in apparent displacement, and when they encountered a second depth of water they felt able to deal with it promptly and efficiently. In other words, after they had mastered one practical situation and had comprehended it in the light of their theoretical knowledge, they were able to take up rapidly and with all of the advantages of earlier experience a new problem which involved both practical adjustment and analysis.

Theory a Summary of Experience

Theory is nothing more nor less than the general statement of accumulated experience. A scheme of thought or a scheme of experience will be stated in the form of a general theory when a whole series of variations can be included under a single general statement. The individual who knows this single general statement can master a series of experiences more readily and accurately, because he knows where to turn his attention and how to harmonize his individual experiences.

The case is the same as that which was discussed earlier in speaking of the sensory controls which appear when one is using a tool. If one knows how the tool looks and the principle upon which it is constructed, he is in a position later when he comes to use this tool to turn his attention to the phases of experiences which will be most useful in guiding him. So theory helps the practical worker to guide his attention and to understand the situation in which he has come.

Theory and Practical Behavior Separate in Nature and Development

If one studies the development of theoretical knowledge in the history of the race, he will see that this statement is wholly justified by the way in which theory has developed. We shall come later to the full discussion of science as a subject of school training, but it may be pointed out in this connection that the development of science or theory is not the same as the development of practical skill. There are races which have grown very skillful in the arts but have known nothing of scientific method. Conversely, there have been periods when abstract forms of thought have far outstripped practical activities. The greatest problem of modern society is to take the results of science into industry

and refine the industrial arts under the guidance of theory. The attainment of this desirable end is impeded, however, by the fact that science often develops in one mind while skill develops in another individual. Even where the scientific knowledge and practical skill appear in a single individual, it often happens that this individual fails to apply such science as he knows to practical activities which he takes up at a time when his science lies dormant.

One of the most striking facts in human mental life is the possibility of two experiences failing to influence each other though they present the possibilities of productive combination. The student studies physics during one hour, and then goes into the shop and uses all the laws of mechanics; but because the workshop presents these facts in a different form, he fails to recognize them. The girl takes chemistry and cooking and fails to see the relation between the two.

Theory and Language

The psychology of this situation is perfectly clear in the light of our earlier studies. Theory is ordinarily a form of verbal reaction; practical life is a form of hand reaction.

The boy who tries to hit a target, for example, does not use his vocal cords in this effort at all. He uses his hand; and the experiences which he gets through his eye and through his contact with the dart issue in a muscular adjustment of the hand and arm. If now one turns the boy's attention away from the actual throwing of the dart and points out to him the ray of light as it traverses the water and the air, the boy's mode of reaction to the situation which he contemplates is likely to be a verbal reaction. He describes the situation to himself. This description of the situation is not a practical movement of the hand and arm, nor can it be brought, as we saw above, into relation to practical movements of the hand and arm

without some practice and without some contact with new and complicated opportunities to convert theory into practice. Persistent effort to adjust behavior to different depths of water may develop a more comprehensive form of consciousness, including both verbal description and hand activity.

Opposition between Theory and Practice in Education

This distinction between a verbal description and practical reaction is constantly brought to the attention of the student of education. No more notable illustration of this distinction can be offered to the teacher than the distinction which presents itself in one's own professional experience. One may study the theory of school discipline and yet be wholly unable when it comes to practical contact with students to make the sort of move which will secure good discipline. Theory, on the one side, is a verbal description of a situation; practical activity, on the other, calls for all sorts of adjustments to social complexities, and the practical adjustments involved are essentially different in character from the mere verbal statements.

Industry has again and again shown itself to be divorced from science; and science has very frequently gone, in its theoretical statements, very far away from the practical situations that arise in ordinary industry. So sharp is the antithesis between science and industry in some cases that both parties to the discussion have felt keenly their separation from each other. The theoretical student has been regarded as a mere juggler with words, while the practical operator has been thought of as an unintelligent workman incapable of analyzing his own experiences and certainly unable to transmit to others through clear statements the habits which he himself has acquired.

Instruction in Application Solution of Problem

The antithesis will continue so long as one form of behavior is cultivated without a clear recognition of the possibility of bringing it into productive relation to the other. There must be a higher form of experience than that which connects itself with skill of hand or fluency of verbal expression. Let us adopt the term " application " as a general term to signify the relating of two systems of experience to each other. Our problem then becomes the problem of determining how language can be applied to the industrial arts, and how the industrial arts can be applied to language activities.

Primitive Forms of Learning

Behavior of a practical sort is undoubtedly the original mode of adjustment, both in the animal kingdom and in primitive races. The technical student of psychology notes in his studies of such primitive behavior that it develops through trial and error. The animal which finds itself in a trap or in an inclosure of any kind tries to escape by seeking an exit, now at one point and now at another. It runs blindly about from place to place and tries every possible adjustment. If by accident it makes the right sort of adjustment it may escape from the trap. Success in this case is due merely to energy in keeping up all sorts of lines of endeavor.

The same general formula explains man's efforts to educate animals. One tries to get an animal to perform a trick. He keeps the animal stimulated until finally by a fortunate combination of circumstances the animal does what is wanted. One must be very prompt in rewarding the animal. The reward gives a satisfaction which tends to lead to a repetition of the successful adjustment. Undoubtedly many

human adjustments are of exactly the same type. The workman who, as an apprentice, is given a certain tool learns in the course of his experience some of the skillful methods of using this tool. He tries one method after another without being very fully aware of the fact that he is introducing modifications, until finally by some fortunate accident he succeeds in hitting upon a relatively economical method of doing the work. Satisfied with this accidental adjustment, he now goes on working in that way and makes the adjustment more and more fixed by his constant repetition of it. In an earlier connection it was pointed out that there is little or no motive in practical life for any consideration of the details of such an adjustment. We see accordingly in many practical activities trial and error with little or no analytic thought.

Higher Forms of Learning

Contrast with all of these examples of trial and error the way in which an intelligent man proceeds to deal with a new situation. Let us assume for the moment that a man has been caught as was the animal which we used in an earlier illustration. The man in the trap sits down and carefully considers every phase of the situation. If he should begin to run around as the animal does, trying now this point of attack and now that, we should say of him that he is unintelligent; but his deliberate consideration of the total situation marks him as an intelligent man, and his intellectual processes are evidently being appealed to as important means of extricating him from the difficulty in which he finds himself. The way in which the man is using his mental experiences in this case may be described somewhat as follows: He first takes into his conscious life the situation that lies before him. He sees with his eyes or hears with his ears or feels with his hands the situation as

it now stands. He then proceeds to concentrate his attention upon the different elements of this situation. He does not try to move these elements themselves, but he fixes his attention upon certain aspects of the situation as these appear in his mind. We have described this sort of process in an earlier connection as an analysis of the situation. We may now put the matter in this form: The individual has a conscious process which is a legitimate substitute for the objects about him, and he works over this conscious process preparatory to dealing with the practical situation. Having now analyzed the situation in his own consciousness, he brings to bear upon that phase of the situation which seems to him to be the most worthy of attack all of the memories and experiences of the past. He says to himself: "There is no use in trying to get out in that direction, because the bars are evidently much too strong. There is no use in trying to do anything here, because the wall is too compact and thick. I can, however, by putting together these and these pieces of wood that I find on the other side of the cage get to a point where I may be able to reach over the wall." This mental process of rearranging experiences in the mind before one attempts to deal with the outside world shows the great advantage of mental readjustment over physical readjustment. It is proper to say that one tries a great many experiments in his imagination, and in a sense it is legitimate to call that also a method of trial and error; but the point is, this kind of trial and error which one carries on in consciousness is very economical as contrasted with the kind of trial and error which the animal exhibits when he goes from point to point in the trap and makes futile efforts to attack now this and now that part of the situation. Man has created for himself a world of imaginary experiences in the midst of which he tries to work out adjustments. He tries to see whether new elements of experience may be piled together; and if his conscious

efforts at readjustment satisfy his mind, he may then later try to realize in the external world these readjustments which he has worked out first of all in his conscious imagination.

Language a General Instrument of Application

Thus far in describing the thought-processes of the intelligent man we have spoken in terms which did not clearly depict these processes as forms of behavior. The form of activity which is indispensable for such considerations as we have been describing is language. The man talks matters over with himself. He tries now this formula, now that. When he says to himself, "The wall is too strong," he is classifying his present visual experiences under the whole of his past experience, and that past experience has been marked and deposited for future use with the label "strong." The very power of discrimination by which he turns attention, now to this point, now to that, depends on his use of words as guides to his mental processes. Discrimination, comparison, recall of experiences, classification of experiences, are not terms which imply lack of action. On the contrary, every one is an active term, and the chief instrument of human life in each of these processes is language.

In short, language is the means which man has devised of rearranging his ideas. He first developed language as an instrument of social relations. He took up the facts of experience and passed them on to his neighbor. But very soon he found that a mode of behavior which would shift ideas from mind to mind might advantageously be used for private ends as well as social, and so man turned language into a means of private adaptation. Language is a means of self-adjustment, an instrument of personal recoil upon one's own mental material. It is an active instrument for assorting and rearranging ideas.

PLAY OF IDEAS

There is something very fascinating about the readjustment of ideas in one's own mind. The little child enjoys putting ideas together just because he finds ideas so easy to rearrange. He finds the real world, which he pushes around with his hands, very stubborn. So he puts together ideas with all the freedom of limitless possibilities of readjustment. Some day he will learn the hard lesson that this free putting together of ideas is sometimes useless and often worse than useless as a preparation for practical life. Mere facility in recombinations of ideas is not the final goal of verbal training.

Come back to our man caught in a trap. He wants to distribute his ideas with a view to preparing for escape. Escape means movement of hands and legs. Consideration means rearrangement of ideas with the aid of language. It will be well for our prisoner if he has learned to rearrange ideas and use words in such a way that he can guide his practical behavior by his carefully considered plans. It will be well for him if he has cultivated such a control of his hands and legs that they can ultimately turn into practical acts what his verbal considerations have worked out in his mind. In short, there is a higher form of adjustment than that exhibited either in gross bodily movements or in the finer movements of articulation. The two forms of behavior must be made to influence and promote each other.

ERROR IN REARRANGING IDEAS

This has been the great struggle of human thought. Often the inner reaction is fantastic, unpractical, unsafe as a guide to life. The result is that many people profess to be skeptical about the value of intelligent readjustments. The race as a whole, however, has undoubtedly reached

an entirely different conclusion. Human experience differs from animal experience in the fact that human experience is primarily an experience based upon theoretical considerations and readjustments. The man who is about to do a piece of work sits down and plans it carefully, because the race has found that it is on the whole very much more economical in point of material and in point of energy to proceed after one has made a very careful plan.

When one reaches on such grounds the conclusion that it is desirable to develop a relation between practice and theory, and when one bears in mind the conclusion which has been emphasized through this chapter and earlier chapters, — that there is a fundamental difference between theoretical processes and practical processes, — he sees that there is an important problem in education in developing the power of translating theory into practice and practice into theory. Theory is not identical with practice nor does the existence of practical experience insure theoretical insight. Consequently, in the school one must make an effort to bridge over the chasm between the two. We must say to the student who has studied physics that he ought to try to work out some of the principles of physics in a practical way, and we may say to the student of mechanics in the shop that it is his business to understand the theoretical principles under which he does his work. It is not necessary for the student to work out the relation between theory and practice in every possible case. If he can work out a few simple cases he will be in possession of a principle of transition from theory to practice, and the reverse, which will stand him in good stead in many new situations where this transition from the one type of experience to the other must be worked out. The ordinary school has long realized the importance of making the transition from theory to practical applications. In almost every course of training we find some effort to show the

student the avenues of such application. We have not taken advantage, however, to the extent which we might, of the possibility of developing science in the presence of practical experience through analysis of this experience. We have taught physics and told students that the mechanical world is based upon physics. We have not developed fully the practice of teaching students how to make something with tools and then to subject this activity to the analysis which will make them aware of the way in which theory can be attached to industry.

Union of Theory and Practice

If now we can realize as the outcome of our study of the relation between theory and practice the importance of moving back and forth from theory to practice and from practice to theory, and if we can realize that this movement backward and forward between the two forms of experience must be made a matter of explicit endeavor in the school, we shall have added to our course of study an important series of exercises which are neither purely theoretical on the one hand nor purely practical on the other.

No school can accomplish this purpose without including in its program both verbal reactions and hand reactions. Schools have long tried the experiment of inculcating theory and relying on later life to supply the opportunities for application, but the outcome has been unsatisfactory. If one thinks of industry as a training school in which skill is emphasized to the entire neglect (in most cases) of science, again the pitiful plight of the worker in a modern factory bears testimony to the unsuccess of a training which omits theory. We come back to the conclusion that the school must include both theory and practice for the sake of producing that highest type of human experience — a single comprehensive union of theory and practice.

Difficulties arising out of Specialization

This is a lesson which must be taken to heart on both sides of the discussion. The teacher of science must not refuse to deal with shop work, nor can the teacher of manual training get on without science. The two must work together. That there has been lack of sympathy in the past is due to the fundamental, psychological differences between theoretical and practical activity. The two types of activity may grow up apart from each other. Often the manual-arts teacher illustrates this fact in his lack of knowledge of science. He does not know enough of mechanical science to state the facts of experience which would be encountered in the shop in the formulas of mechanical science. Furthermore, he is very frequently so absorbed in the practical adjustment of the tools to certain types of material that he does not realize the possibilities of a scientific study of the facts with which he is dealing. He very frequently expresses loudly his opposition to the use of books and stigmatizes language as an unworthy form of expression. Conversely, the student of science shows a like onesidedness when he looks down upon handwork as unworthy of recognition in the schools. For him handwork is an unintellectual form of endeavor. It has no relation whatsoever to thought-processes which are of a high and elevated type.

When the student of science and the student of manual training have to meet in the faculty meetings for the purpose of deciding how students shall be trained, each makes an effort to secure as much time for his special line of work as possible; and each regards it as highly desirable that the other's subject should be limited to as short a period as is consistent with the popular demand for variety in the high-school course. If one should propose to a manual-training teacher that part of the time in his course be given

to training in the theory of mechanics, he would probably reply that the student gets too much theory now, and what is needed is some practical contact with real things. Conversely, if the student of physics were urged to do a little manual training in the physics laboratory, he would probably offer as a substitute the conventional laboratory experiments in which the apparatus has been carefully made in some distant city and so arranged that the student can hardly fail to set up the different pieces in the way intended by the manufacturer. The school thus actually fosters the divorcement between theory and practice.

There is another element of the situation which exaggerates this separation between the two subjects. Both subjects are supposed to accomplish as much as possible within their own fields. The teacher feels pressed for time because in the manual-training shop he must introduce the student to fourteen different tools and to several projects which belong in his particular course. The teacher of physics has a textbook in hand and must get over the work in some fashion or other inside of a year. It makes no difference at all to either of these teachers that the student will have to live after he finishes that particular year's course; and it does not seem to be very significant in the thought of either one of these teachers that the student will probably forget something over three fourths of what he has learned in either course. A readjustment which would spend half of the time in each of these courses, actually making the transition in the student's mind from theory to practice, or the reverse, would undoubtedly be in the long run economical of the student's mental energy, and would make available for later life the small residuum of experience which is all that he can possibly carry away from either course.

Correlation of Science and the Manual Arts

The readjustment here recommended is by no means as fanciful as it may seem to some who have not considered the possibilities of working out such a combination. The effort has been made, with a good deal of success, in one of the German schools to make a combination of manual training and physics which shall be advantageous to both subjects. Professor Freeman has made available in English a description of this experiment, in a review of the German book, setting forth the course in detail.[1]

Furthermore, the spirit of this suggestion has been realized on a large scale in a number of experiments which are being tried in this country at the present time; namely, the experiments with part-time classes, which attempt to unite school work of the traditional sort with shop work carried on by students. In these part-time schemes the student is in school during one week or during one month, and during the following week or month is engaged in practical industrial work. The business of the school in this case is not to duplicate the work of the shop, but rather to bring to bear on the problems of the shop the science and mathematics and reading which the student would miss if he were engrossed altogether in the practical industries. On the other hand, it is recognized that his reading and his study are taken up more enthusiastically because in his shop work he is constantly in the presence of practical problems which stimulate him to see the importance of his school studies.[2]

[1] "Manual Training in the Service of Physics," *School Review*, Vol. XVII, 1909, p. 609, reviewing fully Physikalischer Arbeitsunterricht, by O. Frey. Ernst Wunderlich, 1907.

[2] Twenty-fifth Annual Report of the United States Commissioner of Labor, published by the government printing office, 1911. Special title of the report, "Industrial Education. Part-time Schools," pp. 200–205.

CHAPTER XIII

INDUSTRIAL COURSES

Rise and Development of Commercial Courses

With the rapid growth of industrial education during recent years, there have appeared numerous psychological problems which can perhaps best be introduced by describing the observations which one makes when he goes into the classes where work of this sort is being given. The earliest industrial courses to be organized in American high schools were the so-called commercial courses. Before the economic pressure was felt which is now driving the schools and the public at large to recognize the importance of training in the trades, there was a demand for clerks who could take charge of the shipping activities of the country. For a long time the United States has exported enormous amounts of raw material. This country has not needed, therefore, skilled laborers to make up its materials so much as shipping clerks and agents who could supervise transportation. At first the demand for clerks was met by the organization of special schools entirely outside of the control of the public boards of education. Even to-day we have a large number of private business colleges. Something of the character of these institutions can be gathered from the special report prepared by the Chicago City Club on the private institutions in Chicago.[1] In general it is shown in this report that the effort of these institutions is

[1] A Report on Vocational Training in Chicago by a Subcommittee of the Committee on Public Education of the City Club of Chicago (Part III). Published by the City Club of Chicago, 1912.

to give in the shortest possible time those essential forms of training which are required to bring the students into commercial offices.

There can be no doubt at all that these institutions have discovered some of the most efficient methods for training students rapidly in business methods. They criticize the public schools for the long general courses which are required of students, and undoubtedly secure a large part of their patronage because many people are convinced of the validity of these criticisms.

The example of these numerous private business schools, together with the urgent demand on the part of students that they be equipped to enter profitable business engagements immediately upon graduation, has led to the widespread organization of various kinds of commercial courses in the high schools of this country.

Emphasis on Rapid Execution

If one attends the classes conducted by the commercial departments, as for example the classes in bookkeeping or business arithmetic or the exercises in stenography and typewriting, he finds that the methods of procedure are radically different from the methods of procedure which are common in the other courses administered in the school. One of the first ends of these courses is to secure rapid execution. The student is brought, as soon as he enters the course, to realize that one of the urgent demands of the business world is speed. In business arithmetic many of the short methods of work which are given to students are not explained with a view to a full comprehension of the scientific side of the subject. There is no time for a complete scientific explanation, and the student is not called upon to deal with this aspect of the matter. Bookkeeping also is, for the most part, taught as a series of conventions.

Those who take the course are impressed with the necessity of carrying out the work exactly as it is planned in the models which they use rather than with the necessity of understanding the fundamental reasons why this particular method of procedure is economical.

If one reads the literature on typewriting, for example, he finds that there is very little discussion of the reason why a certain position of the hand or a certain course of training is economical. The student is directed what to do, but even the teacher does not understand the reason for the formula. In one recent publication on typewriting, the question of the best position of the hand is discussed. Should one always go back to the home key in order that he may locate the other keys from this point of reference, or should there be a general position of the hand which is free from definite reference to any single point? There seems to be no evidence beyond the testimony of certain interested observers, and this testimony is not carefully worked out in any exact way. This problem could, of course, be definitely solved by simple experiments.

Emphasis on Imitation of Business Conditions

A further general characteristic of these commercial courses is their effort to cultivate, so far as possible, conditions that are exactly similar to those which appear in the industries. One finds in the commercial department that the furniture is made to approximate, as far as possible, the furniture of business offices. It seems necessary in teaching the forms of banking to have the physical paraphernalia of a bank as well as the general problems that confront that kind of an institution.

Perhaps no clearer evidence of this disposition to demand conditions that are like those of the business world can be found than that given in the reiterated statements that

business training and knowledge of the details of business operations are absolutely essential in the training of the teacher. This statement applies not only to the commercial courses, which were the original courses introduced in the high schools, but also in more emphatic form to all of the technical courses, which are rapidly following in the train of the commercial courses. A recent bulletin[1] issued by the National Society for the Promotion of Industrial Education lays great stress on the practical training of the teacher.

THE TRAINING OF TEACHERS

In discussing the qualifications of industrial-school teachers, this report lays great stress upon actual contact with trade.

> The shop instructor must know his trade as fully as does a skilled journeyman: and in addition, must have knowledge of the technical methods in use in the trade together with the command of its drawing, mathematics, science and art. (P. 27.)

Even the teacher who has charge of subjects that are related to the strictly technical subjects is described as follows:

> The ideal teacher of related subjects whom, admittedly, in practice it would be difficult to secure in large numbers, should have *trade* equipment. . . . (P. 28.)
>
> Experience as a wage earner is an asset, as it enables one to gain a sympathetic insight into the needs of the worker, to understand the aims and purposes of the industrial school and its responsibility for the pupil and to the industry. . . . (P. 29.)

[1] *Bulletin No. 19*, "The Selection and Training of Teachers for State-Aid Industrial Schools for Boys and Men." Special report, issued 1914, by the National Society for the Promotion of Industrial Education.

Individual Instruction

Another characteristic of the commercial course which is very conspicuous to the observer is to be found in the fact that the work is very largely individual in character. The class in typewriting is not a social organization as is the class in history or science. Each member of the class is acquiring personal skill and is allowed to progress at a rate which is in keeping with his own development. He goes over a certain number of routine exercises, and as soon as he can produce a perfect copy of one of the exercises he is allowed to progress to the next. Whether the other members of the class are keeping pace with him or not is a matter of indifference. The amount of recitation which one hears in the commercial department is relatively slight. The same statement may be repeated with regard to the technical courses carried on in the shop.

Antithesis between Conventional Courses and Industrial Courses

All of these examples, as well as the general discussions of the problem of industrial education which have recently been presented, emphasize the fact that there is a distinction between the ordinary school procedure and the procedure which is appropriate as one turns to a study of industry.[1]

This antithesis between industrial courses and the ordinary courses of the school program is not a mere matter of school organization. It implies a fundamentally divergent

[1] F. M. Leavitt, Examples of Industrial Education, especially chaps. vii–xiv (Ginn and Company); J. M. Gillette, Vocational Education, especially chaps. xi–xiii (American Book Company, 1910); address by Andrew S. Draper, "The Desirable Uniformity and Diversity in American Education," *Proceedings of the National Education Association*, 1908, p. 215.

conception of the mental processes which are to be developed in students and of the way in which society's demands are to be presented to the growing individual.

Let us consider briefly the psychological consequences of some of the characteristics of industrial courses which have been mentioned above. In the first place, what is the result of requiring that an act be performed at the highest possible speed? All that was said in the chapter on the psychology of skill about the difficulty of recognizing the sensations which one employs in controlling his activities is pertinent to this discussion. If one has to work at a high rate of speed, his attention must always be concentrated upon the results of his work and he has little or no opportunity to study his methods of procedure. Furthermore, there is little disposition to call in question those modes of procedure which have been found in earlier practice to serve the purpose.

The Relation of Scientific Studies in Industry

Industry is seeing the importance at the present time of setting aside certain of its agents to examine very carefully the way in which workingmen move during each of the processes of their labor. These so-called efficiency experts are finding that the product which heretofore has been regarded by commercial concerns as entirely acceptable is ordinarily produced in a relatively uneconomical way. The standards of commerce up to this time have been the standards of a general average of mediocre types of activity. The efficiency expert finds that by careful analysis of some of these mediocre and relatively clumsy forms of activity he can produce a more efficient form of behavior. He brings into the commercial world an entirely new psychological attitude. It is the attitude of analyzing one's movements for the purpose of improving the movements themselves. To be

sure, the ultimate aim is an output which shall be cheaper and perhaps better than that which has been produced by the earlier methods. But the psychology of the situation is that for the time being attention is turned to the process itself, and this is made a subject of careful analytical study.

No clearer evidence could be found than this to show that there is a difference between the ordinary commercial attitude and the intellectual attitude which is common to science. The difficulty with a careful scientific study of one's behavior is that it impedes the progress of the activity for the time being. One cannot deliberate about his activities and work with the speed that is required in practical, competitive commerce. The laborer, therefore, is trained not to deliberate about his activities, but to go forward at the highest possible rate of speed. The business of the class which is to train the worker is thought of in the same spirit, and is held to consist in pointing out some of the methods of work which will bring the worker more promptly to the result and will suppress in his mind any inquiries as to the grounds for these different forms of behavior. He cannot be both a scientist and an efficient laborer in the short period of time which society has allotted him for his training.

The psychologist finds himself confronted here by one of those large social questions which it is not possible for him to deal with inside the limits of his special science. How the individual is to get time for a scientific examination of commercial processes and likewise fill his place in the world as an efficient laborer is indeed a difficult social problem. So long as our manufacturing concerns are organized at the level of competition which is common at present, and so long as the diversities of human nature are as great as they are, the probabilities seem large that a uniform attention to analysis of processes on the part of all students will hardly be attained in education. But if society is to make a distinction between its members, and if the methods of

training the different members of society are to be sharply differentiated, there ought to be a clear consciousness on the part of teachers of the effects on personality of these social stratifications. For example, if it is contended that commercial courses are good for everybody, the antithesis between commercial methods and scientific methods ought certainly to be borne in mind. If, on the other hand, the commercial courses are to be administered to a part of the school population and not to another part, again there should be a perfectly clear knowledge on the part of all that the distinction is a psychological distinction and not merely a distinction of specialized subject matter or content.

Academic Standards and Practical Standards

Again, let us consider the psychological difference between the standards which are set up in the ordinary academic courses and the commercial courses. As indicated above, there is always an appeal in commercial courses to the standards accepted in the business world. The academic world is supposed by the business world to be very lax in its standards. Possibly this criticism of the academic world can be removed in a measure by calling attention to the fact that the teacher always has a sliding scale of standards, which he applies with reasonable discrimination to the different stages of development of his students. One can be very complacent, for example, with a little child who is just beginning to read if he does not read with accuracy and fluency. The standards of the first grade in reading are relatively low as contrasted with the standards which are set in the upper grades. In the same way one is very complacent in educational institutions with the German sentence which is formulated by a student who has been studying German for two semesters. No one asks of a student of this degree of maturity in the schools that

he pay attention chiefly to the results of his work. The teacher is always more or less aware of the fact that the student's mental activity is being perfected even through the errors which he commits. The teacher constantly discounts, therefore, the actual product of a student's work, making allowances for his immaturity.

Commercial teachers and trade teachers, on the other hand, are likely to be very intolerant of mistakes. They do not make any careful study of the student's mental processes which, in many cases, explain the mistakes. Any one who has seen a shop teacher send a boy back to the task of making over his work, without a word of explanation as to the way in which he may improve it, will realize that in many of our shop courses commercial standards are imposed upon the workers with a good deal of vigor, but with little tolerance for their immaturity. In fact, this is supposed to be one of the virtues of shop courses. There is no parleying with students about their loose methods and inefficient work. They must come up to the commercial standards by some means or other. Unless they do reach these standards, their work will be ruthlessly rejected and they will have pointed out to them their lack of preparation for actual contact with the real world.

Not all commercial teachers are open to this type of criticism; but enough of them would be quite willing to accept the description of their methods given above to justify the statement that there is a marked opposition between the methods adapted in teaching ordinary academic subjects and the methods of commercial and trade courses. Whether the one method of procedure or the other is the most advantageous from an educational point of view must, of course, be determined by an empirical study of the effects of each method upon students. The psychologist is probably better acquainted with the effects of the ordinary academic methods of teaching students, and he notes with interest that

the tendency of the academic world at the present time is to pay more and more attention to the mental processes through which students are passing. The movement toward supervised study in all of the academic institutions is one of the most significant movements in current education. Unless industrial teachers also recognize the value of supervised teaching, it is likely that the breach between their courses and methods and the ordinary academic courses will grow wider rather than be eliminated.

SPECIALIZATION

A further psychological principle which emerges from our examination of the practical courses is the principle that industry tends toward specialization. We are urged to prepare brief courses in even the academic subjects which shall eliminate all of the matter that is not relevant to the industrial expectations of the student.[1]

In these continuation schools one of the most significant arrangements is the close correlation of the theoretical foundations of each trade with the instruction in the processes of the trade. That is to say, the mathematics of the school is the mathematics of the shop, whether it is jewelry or shoemaking or carpentry. The same is true of the machinist's mathematics. Similarly the drawing of the school is the drawing of the shop. The problems which the boy finds in the shop to-day are dwelt upon at length in the school to-morrow. In the same way the closest possible relations of the sciences, physical or biological, to the trade concerned are maintained. The youth learns also the history of his trade, civics, and the proper use of his mother tongue in relation to his trade.

This spirit of specialization is entirely intelligible when one studies the historical development of industry. Industry

[1] P. H. Hanus, Beginnings in Industrial Education and Other Educational Discussions, p. 20. Houghton Mifflin Company, 1908.

has always shown itself to be a progressive concentration upon particular types of material. If one wishes to borrow from the anthropologists a very striking illustration of this fact, he learns that for a long period of time man used only one substance, namely, stone, in all of his arts. The reason for this was that he had not discovered the value of other substances and probably was wholly complacent about the substance which he knew so familiarly. It takes an industrial concern a long while to make up its mind to change from one material with which it is familiar to some other material which is less familiar. It takes a long while in any business operation to persuade men to change their methods of procedure. Industry is conservative; and the student who gets a training of an industrial type is likely to be conservative to the extent of excluding from his psychological interests practically all of the concerns which do not bear directly upon the one mode of operation that is familiar in his field.

Consequences of Specialization

This high degree of specialization within any given industry explains in a measure why industry and science have always been relatively aloof from each other. Industry is so conservative that it does not seek to discover the possibilities of change which lie all about it. Science, on the other hand, with its keen interest in the extension of investigation into new fields, is constantly working out principles without attempting to apply these principles to practical situations. Science is an expression of human interest in exploration; industry is an expression of human interest in the conservation of material and the conservation of energy. Science and industry have, therefore, been very inert in seeking relations with each other. One reads in books on education the broad, optimistic statement that knowledge grows with the evolution of industry and

that training in intellectual ways will make more efficient workmen. Even a superficial knowledge of the history of the race makes it clear that, so far as the individual and his training are concerned, there is no ground for this optimism that industry and science will coöperate. In the long run society, as a whole, does develop both industry and science; and in the long run these two types of experience encounter each other and modify each other's points of view. But the union of the two types of interest and the two types of training is one of the most difficult problems of modern civilization.

Is there to be Specialization in Organization?

These facts explain the bitter controversies that have arisen in recent years in educational circles with regard to the organization and administration of industrial education. There is a party of educators — and they are supported by practical business men — who believe that it is quite impossible to organize industrial education under the same roof with general education. They believe that the methods of industrial education are radically different from those of ordinary education. They believe that the spirit of these courses is at variance with the spirit of traditional school work; that a new and unhampered effort to turn human interests in the direction of industry is the only salvation for our times.

Applications must be consciously developed

The psychologist sees in these contentions in favor of a separate organization of industrial courses not a complete and discriminating analysis of the situation, but a violent partisan expression of the psychological facts which all along have been exhibited in the history of science and

industry. The psychologist's solution for the situation is one which calls for the development of that higher form of intellectual mastery which, in an earlier chapter, has been called the power of application. That the power of application is neither abstract science on the one hand nor specialized industry on the other has been fully stated in these earlier paragraphs and may be left at this point without a review of the psychological grounds which were there presented.

New Vocational Courses for Girls

There are plenty of illustrations within the school organization which could be added to that earlier, theoretical discussion in support of the conclusion that science and industry find it very difficult to merge in the school program. Most of the examples which we have used up to this point are examples that relate to the training of boys. Let us choose for the present discussion an example that relates to the training of girls.

High schools have recently taken on, in increasing degree, courses in domestic art and domestic science, it being clearly recognized that, whatever occupation a girl is to enter immediately after her school training, she will inevitably look forward to the ultimate vocation of conducting a household. So universally has this demand for domestic courses been recognized that there has been less question about the introduction of these courses into the school program than about the introduction of any of the other vocational courses. There has been the most sincere effort to articulate these courses with the rest of the work of the school. Furthermore, since cooking involves certain changes that are chemical in type, the suggestion naturally came very early in the development of the domestic courses that the cooking courses should be articulated as intimately

as possible with the courses in chemistry. The result is that we see the most extraordinary efforts to make cooking a science like the science of chemistry. We see, on the other hand, equally extraordinary efforts to make chemistry practical for the girl who is studying cooking.

Failures in the Effort to correlate Science and Practical Courses

Any examination of the actual situation in high schools and colleges will make the unbiased observer perfectly clear that this effort at articulation of chemistry and cooking has been a huge failure. What commonly happens is that a course in organic chemistry or a general course in chemistry is administered with the usual paraphernalia of laboratory exercises and with the usual demands of a strictly quantitative, scientific analysis. The girl is promised, through the whole of this course, that she will get information which is indispensable for her cooking. She then goes to the cooking class and finds that the formulas in this class are loose and unquantitative. Then she finds that the chemical changes which go on in the ordinary food substances are by no means understood by her instructors or by any one who was interested in giving her the known facts of organic chemistry. She finds that there is a whole series of unsolved problems in cooking which are not problems of chemistry at all, but problems of physics or problems of economics. Her confidence in her teacher who has been promising her applications of chemistry breaks down. She feels that there is no correlation between her cooking and the one subject where this correlation was definitely promised, and consequently she gives up, in general, the effort to relate her cooking to the rest of her studies.

Somebody ought to convince the teachers of domestic science that scientific methods can be applied to the

problems of the cooking laboratory quite as much as in any of the problems of chemistry which are studied in the ordinary elementary courses. The empirical facts which can be ascertained with regard to the changes that take place in meat while it is being roasted are just as important to the human race as any of the laboratory investigations in the chemistry course. A description of these changes under carefully organized, scientific conditions is good science and good mental discipline even if it is not to be classified as chemistry or physics in the ordinary sense of the term. The difficulty, educationally, in these cases is that the correlation has been sought on too narrow a basis. The effort to make industry scientific has started from the foundation of a conventional course in science, without recognizing the fact that this conventional course grew up historically without reference to the particular problems of cooking. The sudden effort to bring the two together without the creation of any intermediate system of ideas is destined, from the outset, to be a failure. The trouble here, as elsewhere in the school program, lies in the assumption that if a student is given two bodies of knowledge, the two will flow together in his mind and affect each other favorably; whereas all school experience goes to show, beyond any peradventure, that two systems of knowledge given to a student are as unlikely to flow together in his mind as two streams on two sides of a watershed.

Courses in Agriculture illustrate the Difficulties of Correlation

Another example of the extreme difficulty of working out correlations between science and industry is to be found in the recent experiments which have been undertaken in agricultural courses in the high school. A very large body of literature has been created on this topic and it would

require a specialist to offer any valid judgments about the actual situation at the present time.[1]

Quoting from the report by Robison, we see that it is the judgment of a specialist that the situation is not materially different from that which is described in connection with cooking and chemistry.

Agriculture is probably taught as well as other sciences in the same schools, but the deficiencies are more common on account of the greater opportunity afforded to make concrete the principles of the various sciences. So much have the sciences been regarded as instruments of a disciplinary education, that the absence of concrete applications has not seemed to many to be such a marked defect. The pedagogy of agricultural instruction must take account of the essentially utilitarian aspect of this subject. The philosophy underlying the method of instruction is not consistent with that conception of education that to be cultural is to be useless; nor does agriculture in the schools depend for its justification on any supposed disciplinary values, not that it does not possess as much value in this direction as other studies, but agriculture as a study may justly claim to have a content of its own that is worth while. It does not need the prop of a disciplinary conception of education that bids fair to become obsolete. But if the administrator's idea is to teach the art or trade of farming, his methods, while involving the idea of doing, will probably be those of purely imitative doing, and not calculated to cultivate initiative, to give opportunity for forming and correcting judgments, nor for acquiring a scientific habit of thought. Viewed as an education, agriculture should do all these things as truly as any other science is supposed to do. We must remember that we are teaching children as well as subjects. (P. 173.)

We do not have to believe that the unrelated chemistry experiment is the only thing giving opportunity for making and

[1] W. G. Hummel and B. R. Hummel, Material and Methods in High School Agriculture (The Macmillan Company, 1913); G. A. Bricker, The Teaching of Agriculture in the High School (The Macmillan Company, 1911); C. H. Robison, Agricultural Instruction in the Public High Schools of the United States (Teachers College, 1911).

correcting judgments; nor is this the exclusive attribute of that particular kind of mathematical physics that is killing itself off except as bolstered up by college entrance requirements. The contests between the disciplinarians and the phenomenologists tend to drive the latter class into an extreme and untenable position. The remark made recently that "there are no methods of teaching above the grades" is not an indictment of the high school instruction and not of pedagogy. Even in the grades the current methods of carrying on garden work are not calculated to encourage initiative on the part of the child or to place any definite problems before him for solution. It is often only a sort of physical exercise that is better than gymnasium work because it is out of doors. (P. 175.)

Problems of Application and Discipline

This last quotation leaves us with two general psychological problems which we must canvass more fully in later chapters. One of these problems has been emphasized throughout this chapter. It is the problem of relating science to industrial training. The second problem which is suggested by Mr. Robison is the general problem of mental discipline, to which he refers in the remark that this doctrine of education is rapidly becoming obsolete. We shall reserve for a general chapter the discussion of this topic. But we must take the opportunity of reiterating what was said in an earlier chapter. The ancient languages have borne, because of their completely developed form, a very large burden of the discussion of the general doctrine of formal discipline. Everywhere through the course of study this problem turns up as an important problem. Does one subject have a bearing upon other subjects in the course of study? Does the mental attitude which a child cultivates in one sphere of experience affect his mental life in other spheres? We have seen how entirely possible it is for science and industry to be separated from each other in the

history of the race and in the experience of the individual. We have had occasion to call attention to the grave educational problem which arises out of this fact. We shall later see that any statement that subjects are not related to each other is of cardinal importance to the educator and cannot be dismissed by the mere assertion that at present relations do or do not exist. The important question for the student of education is how can school work be organized so as to gain as intimate a relationship as possible between the different mental processes which the student cultivates. No educational scheme is adequately worked out which has to be characterized by the statement that two subjects are so remote from each other that one may go on developing without influencing the other.

This chapter leaves us with a clearly defined problem. A solution of this problem can be reached only through further analyses of related subjects.

CHAPTER XIV

SCIENCE

Difficulty of organizing Science Instruction

Throughout the last few chapters the implication that science cultivates a type of experience which is desirable has been expressed without any serious effort to justify the position assumed. When we turn to the school situation we find much to discourage the assumption that science is a successful element of the course of study. As was pointed out in the introductory chapter, twenty years ago there was the most unqualified optimism among those who were active in introducing science into school programs. They were emphatic in the assertion, which cannot be denied, that science lies at the foundation of modern industrial development. They called attention to the popular interest in scientific discovery and to the vast improvement and enlargement of the methods of research. They assumed that it would be easy to introduce students to science. Experience has served to temper this optimism. During two decades the percentage of election of science courses has steadily decreased. Textbook after textbook has appeared and been discarded. High-school administrators say that the teaching in science is not as effective as the teaching in literary subjects. The various courses in the different sciences show no coherence, and the outcome in the way of practical applications made by students is so meager that the value of science teaching is, on every hand, seriously called in question. Certainly if any situation ever demanded careful examination, it is this failure of science to establish

itself in an age when science is popularly thought of as the most productive type of intellectual activity.

The discoveries which have been made by science teachers during this period of discouragement may be summarized in the following statements. The scientific attitude of mind is by no means a simple attitude, and it is not one which is readily assumed by the immature thinker. The interest of the student in the things about him, which interest it was assumed would prepare him for science, is, as a matter of fact, utterly unscientific and so far from furnishing the basis for scientific study that in many cases it creates a prejudice against science. While science has had a powerful influence on industrial development, scientific thought and practical skill are not identical forms of mental activity. Indeed, science and skill are, as we have seen, the most diverse aspects of mental development. It is only in the later stages of the two that they are brought into productive relation. The psychological analysis of science teaching ought to make clear the reasons for the difficulties just mentioned and may suggest some methods of overcoming these difficulties.

Primitive Science

Some of the most suggestive psychological studies of science are those which deal with the beginnings of scientific thought among primitive peoples. The savage personified everything about him. If he heard a clap of thunder, it suggested to him the idea of a voice. If he saw the force and power of lightning, he thought of some personal agent behind the flash. The winds and waves and all the other activities of physical nature were for him personal forces. The psychology of these primitive views about nature is the psychology of a very simple kind of interpretation of new phenomena by familiar formulas. Man saw the

phenomena of nature. His mind tended to relate what he saw with the personal experiences which were the familiar facts of his life. The most familiar part of the world was that made up of personal emotions and ideas. These personal attributes he carried over and attached to the phenomena of nature.

Not only was the association of ideas thus made dominated by personal experience, but the thinker was vaguely satisfied with any combination of ideas that comes into consciousness. The little child is in this respect like primitive man; neither one thinks of the difference between a true explanation and a mere fiction. In fact, if the fanciful explanation is full of people, it will be accepted by the immature thinker with the greatest interest. Little children pass, as did the race, through a period of personifying everything. Dolls and hobbyhorses, even chairs and empty rooms, take on personal charcteristics and furnish the child's mind with an unbounded opportunity of recombining personal experiences. The reconstructed personified world is for him just as real as the world of sensory colors and sounds.

Another way of stating the matter is to say that both the savage and the child feel the need for a fuller experience than that which is supplied at any moment by the senses. The child hears a voice, and is impelled by his desire for a fuller experience to look for the source of the voice. The child sees a color, and tries to get in contact with the object so that he may feel its hardness. The demand for a fuller experience is thus a natural expression of the demand of an active mind. In securing fuller experiences the child and the savage unhesitatingly supply ideas from memory. Many times, rather than trouble to look for the source of a sound, one thinks he knows and so supplies the idea needed to make the experience complete. There is, of course, in this supplying of elements from memory the largest possibility of error. The ideas drawn from memory follow the laws

of the inner world, and it is not probable that the laws of the inner world will always agree with the laws of external reality. When, for example, the inner world follows the principle of personification, it gets so much out of harmony with the real facts of the physical world that we think of savage explanations as the sheerest fictions of inner fancy. And such they were. It was long generations before the mind was disciplined to carry out those elaborate and carefully guarded forms of thought which constitute modern science. Science began with uncritical imaginings and has only gradually been disciplined into forms of thought in which the imaginings are brought into agreement with nature and made productive for the control of nature.

Science based on Motives Other than Practical

It may be well at this stage of the discussion to dispose of a view which is often expressed in educational literature. It is said that science grew up as the handmaiden of industry. Nothing could be more untrue than this view. Primitive man had a set of explanations of the world which was immensely more elaborate than were his ideas in industrial matters. He used the stars to guide his ship or his caravan, but his science went very much beyond the study of the positions of the stars. His active mind peopled the firmament with grotesque monsters whose imagined shapes bound together the stars in constellations; and, pursuing a vain hope, he sought to determine his own future by the juxtaposition of the heavenly bodies. To say that early astronomy was a handmaiden of the art of navigation is to pervert immeasurably the history of science.

Again, take the hunting ceremonies of primitive peoples. The peoples depended on game for their food and became most expert in the tracking of animals. The modern scientist can learn from his unscientific guide the most interesting

and important facts out of which to formulate a science of animal life. This is because the guide has much practical information and uses it in tracking game. But the guide is, in his own science, grotesquely crude and uncritical. The primitive hunter, when he sits down by the fire after the day's hunt, lets his imagination have free rein. Then the prey which he tracks so skillfully during the day takes on all sorts of personal characteristics and goes through all kinds of unobserved and unobservable performances. The hunter is now a man of imagination. He is cultivating the powers of thought which some day will mature into critical science, but at this stage he is limited by no restraints of mere observation and by no disposition to collect evidence before he enters upon the formulation of theory.

Ideas shaped Practice Rather than the Reverse

The unrestrained speculations of primitive man are not turned in the direction of science by any effort at application. Indeed, the history of primitive custom shows exactly the reverse, how absurdly man shaped his practices to fit his theory. Think of the practices of sacrifice and religious propitiation. Primitive society put its members through the most onerous tasks to satisfy needs which were wholly of the imagination's making. The history of these practices is to our modern minds like a fairy tale. They are, indeed, part of the fantastic world which man made in his own mind and substituted for the world of his senses. To understand primitive customs one has to study primitive myths. Thought was not controlled by practical adjustments. Quite the contrary, behavior was dominated by fantastic imagination.

Critical Thought arises from Social Relations

The first revisions of primitive science came not from the efforts to reconcile practical behavior and thought, but rather from the clash of social groups. The history of the Greeks illustrates this in a very striking way. The various Greek tribes developed elaborate systems of mythology and elaborate systems of ceremonial practices. Each tribe was content to believe its own myths until tribe began to come into intimate relation with tribe. Then the clash of social opinion made men skeptical. There is nothing more jarring to one's primitive scientific theories than to find that one cannot persuade his neighbor. So it was with the Greek thinkers. At first each developed his own views without restraint, but soon he met some one who had evolved other views. Now came the clash of wits which characterize that period of Greek skepticism that introduced the first great constructive period of Western thought. During the period of skepticism the Greeks learned that thought, to be productive, must be critical as well as imaginative.

Not only does the thought of a whole tribe thus progress through social conflicts to a stage where criticism checks and organizes imaginations, but there appears during this social checking up of ideas a tendency for the thoughts of each individual to become more systematic and internally coherent. This is most conspicuous in those purely mythological systems such as the system of the Greek gods and goddesses. The system gradually cultivated a kind of inner coherence, and all new experiences which were allowed place in the system were made to conform to the general scheme. Indeed we find that the hierarchy of gods was made to conform more and more to a well-arranged human state, thus revealing not only system but a system of a very familiar type.

Internal Consistency as a Logical Criterion

Thus the first principle of validity arises and gets a general social recognition. Thinking is regarded as valid when it is consistent with itself. There is no psychological demand at the outset for conformity with any external facts. All that is necessary is that ideas shall not contradict earlier ideas.

This criterion of internal consistency is the one which is used even to-day in testing much of our scientific thinking. If the geologist has a theory with regard to the formation of the earth's surface which he cannot test with reference to its actual agreement with external facts, he offers as evidence of the validity of his theory the criterion that his theory includes all that is known without presenting any internal inconsistencies. Indeed, one may say that the whole of formal logic is based on this criterion of internal consistencies. One may reason validly in non-Euclidean geometry where his assumptions are known from the first to be actually contrary to fact as observed. One may be mistaken in his premises but consistent in his inferences. To be sure, modern science has developed methods of testing premises as well as methods of testing processes of inference, but it is interesting to note that science is, in its attitude toward the criterion of consistency, very different from the so-called practical man. The man of science is willing to go through a long and laborious comparison of different ideas for the purpose of testing their internal coherency. The practical man, on the other hand, cuts short this comparison of ideas and resorts to the practical test. If the thing works, it is enough for him. If, on the other hand, it does not work, the practical man casts it aside, whatever may be its scientific probability. The scientist very frequently has to hold to the validity of his views, because they meet the criterion of internal consistency, for

a long period before he is able to refine the instruments of demonstration far enough to persuade a practical man of the workableness of the theory.

There is so wide a breach between practical tests of validity and the demand for consistency that at the outset the practical tests cut no figure. Primitive man was satisfied when his stories held together, quite apart from their application in any way to practical life. It is only in the latest and most elaborate stages of science and industry that internal consistency and practical applicability are both recognized as equally valid methods of testing thinking. It is only when these two entirely different attitudes of mind and means of criticism are equally applied to thought that we get the highest productivity of thinking. For long generations the two types of criticism of truth were separated from each other. For example, the medieval theologian cared not at all for practical applicability. Many a practical man cares not at all about theoretical consistencies. It is only the modern worker, trained in applying science to industry, who can see the importance of both criteria of validity.

Imagination reconstructs Environment

Another way of stating the same case and of reviewing the earlier discussion is to say that ideas may be put together in the freest possible fashion. For primitive man the putting together of ideas was itself a pleasure quite apart from any use which could be made of these imaginations. The same is true in the personal experience of each of us. We all get pleasure out of pure imagination. We build castles in the air and construct in thought combinations of ideas which satisfy our desires. It is much easier to satisfy one's desires in this thought world than in the world of actual reality. Indeed, so free is the thought

world from agreement with external things that very frequently it is difficult to see how free imaginations come to be disciplined into service in a world where men live and move under the limitations of external things. It is not until we realize that the ideas which one puts together freely in thought are capable of being used as models on the pattern of which to rearrange external reality that we see the possibility of uniting the two interests. It is one of the most striking characteristics of human life that man has turned upon his environment and has, through his industrial and practical arts, remolded the environment to fit his ideas. Instead of changing himself to fit the external conditions of climate, as did the animals during the process of organic evolution, man has gone about changing the external conditions around him in such a way that he has freed himself from the necessity of changing his own physical characteristics. Anthropologists have long called attention to the fact that the physical changes which man has undergone in the course of his whole history are relatively very slight. Man of to-day is not different in size and general physical equipment from man when he first appeared on the earth's surface. The fact is, he has not been progressing physically during the period which anthropology has studied. When we study his behavior we see that there is no reason why he should change physically. He has evolved a very much better plan of adaptation to his environment. He now reorganizes his surroundings. Instead of becoming strong in his own arms and legs he devises mechanical substitutes for his own weakness. Instead of learning how to fight the animal kingdom better, he takes the beasts into his service and domesticates those animals which will be of use to him in maintaining his own life. These processes of mechanical invention and of domestication of animals have been made possible through the fact that man was able in his own

thinking to rearrange the world and then by his actions to make the external world conform to the world which he had imagined.

It is well, therefore, that the internal world of imagination should be freer than the external world of things. It is because of the freedom with which man can readjust his inner world that he has been able to make his great strides in civilization. In this inner world of free recombination of ideas man was at first without restraint of any kind. Then he came to demand internal consistency. All that he asked of his ideas at the beginning was that they should not disagree with each other. During this early period his ideas were not very useful; indeed, they often misled him. Later he realized the advantage that would come to him if he could accomplish in the external world what he thought of in the world of ideas. Then he began to try and test his imaginations by the possibilities of realization in the external world. Now a new type of thought was created; namely, experimental research.

Critical Thinking Late in Development

Such considerations explain how the transition gradually takes place from the first unsystematic imaginings of primitive man to the critical, systematic thought of the modern sciences. How slow this evolution has been one realizes when he remembers that not until the most modern period has science come to be the dominant mode of thought. Earlier centuries were speculative, theological, romantic. Only the last centuries have been scientific. We should keep in mind this slow development of science when we propose a course for the school. Can children learn to substitute something better for their imaginations about the world? Can children learn the lesson of self-criticism? Can children become systematic and at the same time

learn to conform their systems of thinking to the world of physical phenomena? The answer suggested by the history of science to these questions is not encouraging. The race learned scientific modes of thought very late and after a long period of intellectual struggle in which error dominated. How then shall the child escape some of these difficulties? When one recalls the fact that experimental methods are among the latest achievements of the race, he understands in a measure why the efforts of science teachers to introduce experimental methods into schools have met with a serious rebuff.

Specialization in Science

If we turn from the first beginnings of science and consider some of the later periods of its history, we shall realize more fully another cardinal difficulty in promoting scientific thought and teaching. Science, as a system of experience, tends to become highly specialized. This is due to the fact that individuals who pursue one system of ideas for a time tend to become limited in thought and action to that one field of experience. The mind is narrow in its ranges of attention, and, whatever may be the possibilities of extension of any system of ideas, the tendency in the life of a single individual is to narrow all experience down to a single type. While society as a whole may be interested in different systems of ideas, the individual tends to become a specialist. This tendency is so often exemplified that it seems unnecessary to offer illustrations in support of the above statement. The psychology of science as well as of industry would, however, be incomplete without great emphasis on this principle.

It may be well, therefore, to consider one of the striking examples of specialization which appears in the history of science. The science of chemistry grew out of a

semipractical and general interest. Men had long known the metals and were familiar with their uses and with many methods of treating them in art and industry. The theory, which we now know to be a pure fiction of human desire, that baser metals can be turned into gold, led men to make trials and to enter into the most elaborate schemes in order to make Nature conform to their theory. But Nature was stubborn, and as men worked to achieve their desired goal they became more and more conscious of the fact that Nature follows certain laws altogether different from those which human speculation had planned. The shock of disappointment was great, and some of those who had entered upon the search for the desired power to change metals gave up discouraged. Others became absorbed in a wholly new quest. Finding that Nature has her own laws, they began to inquire into these laws. So deeply did these searchers after Nature's laws become immersed in their study that they lost contact with the world about them. They appear in history as a group of men devoted to a special search. They cultivated a language and a fraternity of their own. They did not ask about the uses which could be made of their findings. They were bent only on enlarging the one type of knowledge. This one type of knowledge became to them an absolutely engrossing interest, a religion.

Specialization due to Limitations of Attention

To the psychologist who reads the history of the beginnings and the later development of chemistry the lesson is clear. The human mind is relatively narrow in its interests. Once a man becomes absorbed in a certain type and system of thought, he has no attention for anything outside the sphere of this one dominant interest. One needs only to go into any modern chemical laboratory to find descendants of the alchemists buried in their cult. The research chemist

turns his mind to the task of determining specific gravities and for him there is only one interest in life. He is an example of the narrow scope of human attention. Such a research man has no interest in industrial applications. He looks upon application of knowledge as a distraction. If one is to discover facts and the laws of chemical behavior of substances, he must think of these, and only these, day and night. When society at large looks in upon such a devotee of science at his work, it turns away with an uncanny feeling that he has ceased to be a part of the normal human group. Most men have limits of attention that are narrower than those of the research student, but the common narrowness of ordinary men seems broader because the ordinary man flits from problem to problem and gains in breadth of objects touched by scattering his limited powers in many directions. The research student holds to one group of facts and so stands forth convicted of human narrowness.

Dangers of Specialization

The growth of specialization in modern civilization is one of the drawbacks of a highly scientific age. The physicist of to-day is likely to think slightingly of his fellows who work in botany and zoölogy. New sciences are always received with coldness. For example, the science of psychology is so different from the natural sciences in method and material that it has made its way slowly against the critical skepticism of these older sciences. The antithesis between applied science and theoretical science is sometimes emphasized to the point of bitterness. The only salvation in the situation is that society as a whole overcomes some of the narrowness of its individual members. The chemical researcher is supplemented by the practical man who dyes cloth and tans leather and makes sugar. Society is

gradually evolving special agencies to help her in overcoming the narrowness of specialists. She is evolving specialists whose business it is to bring to narrow-minded practical workers the results of the researches of narrow-minded students of science. These middlemen are sometimes unable to get the sympathy of either group whose efforts they are trying to unify. Society needs the student of applied chemistry, however, and will doubtless be able to support him until his place in the scheme of human effort becomes established.

The narrowness of specialization in the sciences is the source of one of the gravest problems of the modern school. How shall the student be put in contact with science and be shown the meaning of scientific method when the typical attitude of the scientist is narrow devotion to a single limited field? The high-school course of study of to-day shows how difficult is the answer. Shall there be short highly specialized science courses giving the student glimpses into each of the great divisions of science? Shall there be courses giving a few sample problems and solutions from biology and a like number from physics? Shall the student be given results, being told in the easiest possible way what science has learned, or shall he be brought into the laboratory and guided in the discovery? Shall he elect science after he finds out from his reading or through his endeavor to keep up with modern practical life that science would give him the typical modern view of the world, or shall he be required for the good of his soul to take some science whether he has learned to want it or not? Shall high-school science be exact and in its most final form, full of mathematical statements and rigid and complete in its demonstrations, or shall it aim to persuade the immature student to look at the world in a critical and systematic way? Shall we teach applications in the first stages of science, thus reversing the history of science, or shall we

wait for applications until science is mature? These and a hundred other questions are difficult to answer because those in charge of science courses are narrow-minded like all human beings.

The Need of General Studies of Educational Situations

How narrow science makes one was illustrated in the writer's hearing by a colleague who described the requirements which a certain university department of physics was attempting to enforce upon graduates of that institution who wanted to secure recommendations to teach physics. The department wanted all intending teachers of physics in high schools to take three fifths of their courses in that department. It can be shown, and was shown in the case in question, that in no high school in that state could a teacher be found who taught physics alone. Physics, then, was only part of the rational preparation of the prospective teacher. Suppose the second subject to be a science. There would be no adequate margin in the student's course for training on a like scale even in this second subject, to say nothing about the general courses in literature and history which it is commonly thought a student should pursue.

The Need of a General Curriculum of Science Courses

Another symptom of the limitation of the ordinary scientist's horizon is seen in the fact that after all these years no one has devised a high-school course which extends through a period of four years. Do the science people realize the enormous disadvantage to their subjects which results from their absorption in their specialties to such an extent that they cannot get together and agree as

to the advice which should be given to students about the proper sequence of science courses? The following table, compiled by Professor Caldwell from statistics given by G. W. Hunter,[1] shows the present chaotic state of the art of teaching science.

SUMMARY MADE FROM TWO HUNDRED AND SEVENTY-SIX SCHOOLS

	First Year	Second Year	Third Year	Fourth Year
Botany	76	94	26	29
General Biology	36	23	7	7
Human Physiology	105	34	21	33
General Science	9	0	0	0
Physical Geography	94	49	6	17
Zoölogy	27	84	24	15
Physics	13	25	148	90
Chemistry	0	8	94	146
Astronomy and Geology	0	0	8	23

General Science as an Introductory Course

One suggestion which has been offered with reference especially to the first-year course is that a composite general course be organized including material from various special sciences. To be sure, the onlooker sees evidences of specialization even in these general courses. One of the general courses is based on physics and another on biology. The scientist has his specialty as his chief topic of attention even when he tries to be general. These courses in general science, whatever may be their virtues, are condemned by most specialists as unscientific, and they are found by administrative officers to be difficult to keep alive because the supply of teachers of such courses seems to be short.

[1] *School Science and Mathematics*, Vol. X, 1910, p. 3.

A Study of Children's Scientific Interests

The organization of other courses for various years has also been dominated very largely by the supposed interests of the science itself. Is it not time that scientific studies of the mental processes of students be substituted for a too absorbing devotion to scientific studies of physics and botany? One such study, made by Mr. Finley,[1] although it dealt with the interests of children in the elementary school, may be reported as furnishing the clearest evidence that there are successive stages of development in scientific interest. In the investigation in question objects were exhibited to children in the different grades of the elementary school for the purpose of determining the type and distribution of their interests. In the first part of the experiment the children were shown a water animal, and their interests were tested by the questions they asked. In the second part of the experiment a plant and an animal were exhibited and a simple physical apparatus was demonstrated, and the interest was measured by the choice made by the children later of a subject on which to write.

Two striking facts came out of the investigation. First, there is a radical change in the attitude of the children as we pass upward through the grades. In the earlier grades the interests of the children can be described as centered on mere identification or on purely personal relations. The questions asked were such as these: "What is it?" "May I touch it?" "Will it bite?" Obviously these questions are not scientific at all. There is no interest indicated in them in a critical study of the structure or function of the thing itself. There is only a crude, personal interest manifested as the earliest type of interest which children have in the world about them. In the later grades evidence

[1] Unpublished Master's Thesis in the Department of Education, The University of Chicago.

began to appear of interest in the structure of the animal and in its life history. This higher type of interest had been fostered in the school by nature study, so that even here it may be that the apparent interest of the children in structure and function was an expression rather of the results of instruction than of a natural and spontaneous interest in these aspects of reality. At all events, whether induced by the classroom work or by the natural growth of the child's experience, we have evidence here of a change from an earlier unscientific attitude to a later scientific attitude.

In the second place, it became apparent that different classes of facts commanded the interest of children in different degrees. It has usually been assumed in discussing children's interest that they will early and spontaneously turn to the scientific study of animals. We all know that children are interested in animals, and the inference has often been uncritically drawn that all interest is scientific interest. It is only later, we are told in the older books on education and in the prefaces to nature-study books, that children can be interested in objects which are inanimate or do not move. Now it appears from the investigation that some children are very much interested in simple mechanical phenomena. They comprehend such facts very much more readily than they comprehend the structure and function of animals. In this particular experiment one of the lower classes showed an overwhelming interest in the pendulum, and some of them preferred the plant to the animal. With these facts before us we must explain the universal interest of children in animals as unscientific. They are interested in animals because animals have so many characteristics which the child recognizes as personal characteristics. It is so easy to personify an animal that the child begins in the early stages of experience by feeling a very large sympathy for the animal, and just because of

this close personal friendliness, he is far from desiring any structural or functional knowledge about it. If one points to the history of science, he can easily show that man studies last his own bodily structure and only in the latest stages of scientific development did he study animals. All of the biological sciences are very recent sciences so far as the race is concerned, and that for exactly the same reason that the scientific study of biological facts is very much more difficult for the child than the study of simple mechanical devices.

Study of the Relation of Drawing to Science Instruction

A second investigation which has much to contribute to the psychology of science is one in which Mr. F. C. Ayer[1] has studied the usefulness of drawing as a means of instruction in science courses. It is commonly assumed that representative drawings ought to constitute a very large part of a course in science. Since laboratory notebooks came to be regarded as necessary, one finds a demand frequently reiterated that students make sketches in these books. The attention of Mr. Ayer was drawn to this problem through two sets of considerations. In the first place, it did not appear on superficial examination of the standings of students that those who can draw best are the best students from the point of view of the teacher of science. In the second place, it was evident from the psychologist's point of view that drawing calls for types of training and interest by no means identical with those required for science. Mr. Ayer was led, therefore, to make a more rigid comparison, and it appeared that his skepticism with regard to the relation

[1] Unpublished studies in the Department of Education, The University of Chicago. See also L. de Boisbaudran, The Training of the Memory in Art. The Macmillan Company, 1911.

between drawing and science was entirely justified. It appeared that there is very little correlation between the ability to draw and the standing of the student either in science or in his general courses. He found that the student may pay the strictest attention to the aspects of an object necessary for correct representative drawing without becoming conscious of the scientific import of the same details. Furthermore, it did not appear that improvement in science and improvement in drawing go hand in hand. The student who shows an increasing degree of efficiency in science may remain entirely static at a low level of ability to draw. Conversely, the person who improves in his ability to draw does not necessarily show any improvement in his science work. This negative result must, however, be paralleled by a positive statement regarding the relation between drawing and science work. Mr. Ayer was able to show on the positive side that the ability to make a sketch which points out in careful analytical detail those characteristics of an object which are of importance for the purposes of scientific explanation develops in parallel with the development of scientific thought itself. Thus, if we are studying the habits of a bird and it is desirable that we should know something about the type of food which the bird lives on, we may with propriety ask the student to make a drawing which will show the function of the bird's beak. If we wish to find out in what kind of an environment the bird lives, it is desirable that the student should make such sketches of the bird's feet and of its plumage as will show the relation of these structures to environment. Thus the study of drawing confirms the conclusion that it is very desirable that students should be able to analyze the objects which they are studying.

Analytical drawing as distinguished from mere making of pictures seems, therefore, to be the solution of our problem. One may say that scientific analysis must always have

a definite motive. Attention on the part of a student cannot be too widely distributed over the object as a whole, if he is to be a good scientist. Furthermore, he must not be left to be guided merely by his accidental appreciation of this or that element of form. The student who is to use an object for scientific study must be guided by a definite principle of selection and analysis. He must look at the object with a view to finding out exactly how far the characteristics of this object are related to the one problem which he is at that moment trying to solve. Scientific drawing thus appears to be guided thought; science helps the student to distinguish from the mass of elements of experience those elements which are significant from a particular point of view. In a certain sense of the word scientific thought is thus seen to be narrow and limited. One turns away from the general characteristics of the situation to the particular characteristics and is guided in this specialization by definite principles and interests.

We have already seen that there are ample evidences for the statement that science is highly specialized. So also in this matter of scientific drawing or sketching we see that it is specialized sketching which is of value. Only after the student has worked out each of the details of an object from some particular scientific point of view can he come back to the more comprehensive and general problem of fitting these details together in one comprehensive study of the whole. A comprehensive study of the whole situation or a synthetic study of the object is, therefore, one of the very late products of scientific thought. Analysis or specialization naturally precedes the later grasp of the object as a whole. The experiments reviewed in an earlier chapter, where an example was given of the development of an individual recognition of a figure, illustrate this principle very clearly.

Science must unify Experience

The synthetic mental processes by which science attempts to build up in the minds of students a complete idea of the world are quite as important for psychology as the analytic processes which have just been discussed.

Primitive Efforts at Unification

Again an illustration from primitive science will help us. The Greeks saw a part of the relations of the earth to the sun; they observed the sun travel from day to day across the sky and they tried to formulate some idea of the way in which this could happen. To their minds the largest and most powerful instrument of movement was a horse and chariot. Consequently, they gave the sun in their thought all of the machinery of movement across the heavens that their imagination could devise, and the form of this imagined means of movement was a chariot with horses. We regard this idea of the Greeks as very crude. All of their stories about how the horses ran away, and about the coming of the sun down toward the earth and scorching the desert, seem to us to be very childish — because the imagery is wholly inadequate, and is so obviously inadequate that their satisfaction with it causes us no end of wonder at their simplicity of mind.

In the same way we often find that the explanations of facts offered by children are picturesque, but ridiculous. What is inside of a mechanical toy, for example? Since the child does not know anything about mechanics, he is very likely to think that there is some person or some animal inside. This simple explanation is merely the effort of the child to get an idea which will fill out his experience. He will be disappointed when he opens up the toy and finds nothing of the kind. Indeed, the astonishment with which

he will be filled when he comes in contact with the real facts of the case is comparable to the reluctance exhibited by the race to substitute mechanical forces for the agencies that they originally assumed for all sorts of natural phenomena.

Unification through the Development of Systems of Ideas

In view of this difficulty of supplying children with adequate systems of ideas, we find much of our modern science instruction engrossed in the task of filling the minds of children with the right kind of supplementary ideas. One sees elaborate models of mechanical principles and of physiological organs. These models are constructed in the effort to give children proper systems of ideas.

One of the best lessons that the writer ever heard in physics illustrates admirably what is needed in order to introduce elementary students to some adequate notion of physical forces. The lesson in question was a lesson on the transmission of heat. The instructor began by furnishing the students with the imagery necessary to enable them to picture to themselves the molecules and their relations. He asked them if they had ever noticed the way in which bricks are carried in the construction of a building from the supply to the point where they are to be used. By questioning the class he brought out the fact that there are at least two entirely different ways in which the bricks may thus be carried. In one case a line of workmen is formed and the bricks are passed directly from one to the other along the line. In the second case one workman takes a hodful of bricks and goes the whole distance. With this analogy in mind, he gave some simple demonstrations to show that in some cases the heat which is applied to substances, such as iron, is passed along rapidly from molecule to molecule. This is analogous to the action of the line of workmen who

pass the bricks from man to man. On the other hand, in the case of water there is no rapid transmission of heat from molecule to molecule, but heat must be carried by a change in the position of the heated water particles. He gave a demonstration to show that if water is heated, there is a tendency for its particles to take their load of heat and move to a new position. They do not, in this case, pass the heat to other molecules directly, but they keep the load of heat and move about, thus giving the phenomena of convection.

In general, molecular phenomena are much more abstract for students than are the mechanical phenomena treated in the first chapter of physics. Put into psychological terms, this statement means that students have great difficulty in forming coherent systems of ideas about molecules, while they can more readily think their way through the mechanical processes, which are more open to direct observation. The effect of this greater difficulty in understanding molecular phenomena is that in American high schools very little attention is given to chemistry and to those forms of physical phenomena which are chiefly molecular. In European schools, where one of the guiding motives for the introduction of science has been the practical application of these sciences to industry, more attention has been given to chemistry than in this country. Foreign visitors in our secondary schools are very much surprised to find that we do not have special courses that are centered around the chemistry of industry. The common practice here is undoubtedly due to the psychological difficulty of teaching an abstract subject.

Formalism encouraged by Abstract Instruction

The abstract character of much science further results in the student's giving up the effort to acquire a real system of ideas; he resorts to the easier method of learning the

sentences given him in his text. The difficulty in such cases is that the student never gets an independent mastery of the methods of science, and merely follows the verbal formulas of some scientist who has turned observation into verbal description and verbal formulas. Words are not to be condemned as unscientific. Indeed, science could not develop without these essential aids to abstract thought. The trouble is that where finished verbal formulas are substituted in the mind of a student for systems of ideas, science is subordinated to words rather than aided by them. The grave problem which confronts the science teacher is the problem of making sure that the student shall learn how to guide himself in critical thought even when he must deal with abstractions and words.

Courses in Construction not inherently Scientific

One of the suggestions which has been offered is that the student can be made scientific if he is confronted with constructive problems. Let him feel the desire to do something, and he will learn to use his mind in satisfying his desire. He will be driven to thinking. Sometimes the explicit statement is made that scientific investigations grow, of necessity, out of practical situations. The introduction of practical arts is accordingly offered as the solution of the educational problem. Put a boy in the workshop at the task of making something, and he will discover that he needs to know how to use a ruler. He needs to know, also, something about the science of mechanics. Stimulated by these practical necessities, he will turn eagerly to the study of mathematics and physics. Enough has been shown in connection with the study of the history of the sciences to make it clear that this is an unfounded doctrine. Practical industry does not automatically arouse the scientific attitude

as its natural consequence. Anyone who is confronted with the desire to make something is likely to resort to the crudest means if he is not trained beforehand to adopt more scientific methods. Instead of studying science and mathematics, the boy who wants to make something usually patches together a very crude device, expending as little time and energy as possible on consideration. Furthermore, the ordinary attitude of mind is one in which desire for practical results often fails to arouse even the crudest activities. All of us would be very glad indeed to have devices around the house which would satisfy our needs, but we give up without even attempting to think of the ways in which these problems could be solved. In short, there are many needs which are really urgent but are entirely ignored by even the most practical men.

Problems must be intellectually apprehended

Perhaps one of the best illustrations of this fact is to be found in the unintelligent way in which many communities ignore their really urgent needs for improvement of sanitary conditions. Savage tribes encountered a great many inconveniences and often diseases because of the lack of sanitary conditions in their villages. Modern cities in the tropics have frequently suffered seriously because of lack of appreciation of the needs of sanitation. Most children have a natural neglect of dirt that has to be eradicated by artificial training. In other words, the importance of keeping clean and the importance of sanitary measures have to be learned through a study of the situation. A community has to be persuaded that it has this sanitary problem before it will adopt measures to relieve itself of the inconveniences and dangers that come from ignoring its problem.

Primitive man had need of mechanical devices, but he had not the remotest imagination of the possibilities of

machinery. Slowly he progressed by very short steps from the natural weapons which he picked from the ground to a modification of these, in the direction of greater usefulness and greater convenience. Slowly he learned, usually through social comparisons, that there are possibilities of securing better tools and better instruments of warfare. Still more slowly he learned that thought about the mechanical principles which he employs will facilitate the development of more elaborate and perfect tools. As the outcome of this very gradual development man is now keen about his needs and about the possibility of applying science to the solution of these needs; but the situation which has thus resulted from long experience can in no proper sense of the word be described as a natural or spontaneous interest in science. The problems which man has discovered are not natural problems which force their attention upon the ignorant or the inattentive. One must learn to see the problems about him. One must have a certain stock of problems and their solution in mind, as examples, before he will realize that the problem-seeking attitude is a productive attitude of mind. The ordinary member of society does not seek problems of social reform. He does not seek problems of personal improvement. He does not seek problems in the world of vegetable and animal life about him. He simply goes through the world adjusting himself in a crude and inadequate way to the various experiences with which he comes in contact.

Science develops only when Problems are understood

The scientific specialist knows that there are problems in a certain sphere of reality, but he is not likely to be keen about problems in other directions. After one has examined minutely the structure of a certain set of animals or plants he sees familiar problems whenever he encounters a related

plant or animal. The zoölogist and botanist, therefore, are always prepared to raise questions in the sphere in which they have had some experience. The man who is interested in politics or government sees the problems in that sphere of life, but he does not see the problems of the zoölogist or botanist. He cannot understand how anyone will devote to the structure of animals and plants the amount of time and enthusiasm that the zoölogist and botanist are ready to bestow upon the facts in which they are interested. The teacher sees problems related to school organization which the community cannot understand at all. The student of architecture sees problems in every house which he passes, while the ordinary observer fails utterly to realize what it is that absorbs the architect.

In all these cases the first stage in cultivating the attitude of mind which is to be defined as scientific is that of discovering problems rather than that of seeking solutions. In the same way, the business of the high-school course of science consists not merely in giving the solution of problems; it consists rather in stimulating the student to see that there are problems to be solved. The difficulty with most of the science textbooks and with much of the laboratory work is that the effort of the teacher is devoted to giving the student results. Science in its completed form is a statement of solutions of problems. Science in the personal form in which the student needs to acquire it consists in the stating of problems in such a way as to give the student an appreciation of the reason why anybody should try to work at the subject. There is nothing more fatal to mental life than the learning of solutions of problems which are wholly artificial to the student and not appreciated by him as having any significance either for himself or for society. On the other hand, if one can get a student to see that the facts of life ought to arouse his curiosity, a very large part of the difficulty in science teaching disappears.

Strange Facts make Problems easy to recognize

It is sometimes suggested that science ought to begin with the study of familiar facts. Psychologically it is very difficult to see a problem in a familiar fact. It was pointed out in connection with the study of the manual arts that an analysis of a familiar situation is difficult just because of its familiarity. The same general fact was referred to in connection with the discussion of language teaching. It is very difficult to get students to think about their mother tongue in any such way as to arouse an interest in the structure of the language. It is much simpler to get a person interested in a foreign language and to get him to discuss this language from the point of view of its structure and vocabulary. In short, it is the unfamiliar which presents obvious problems. One finds a concession to this natural psychological attitude in some of the supplementary readers on science which are put into the hands of students. Remote problems of a type which are utterly unfamiliar to the student's ordinary experience are offered in these books as the most stimulating body of material with which to interest the student in scientific investigations. Strange plants and animals are described, and their modes of life pointed out, as the means of drawing the attention of the student to the fact that plants and animals have peculiarities which need to be studied. One can frequently interest a student in mechanical devices by referring to some new and elaborate and, on the whole, mysterious mechanical contrivance. It has been found relatively easy, for example, to interest boys and older people in wireless telegraphy, because that is a new invention and difficult to explain and understand. One hardly feels the necessity of interesting himself particularly in an ordinary telephone, because it is so familiar. An appeal to the relatively strange is undoubtedly legitimate as an introduction to science.

Ultimately the Student must discover Problems in Familiar Facts

On the other hand, a continual diet of strange and wonderful things distorts the student's attitude toward science in such an extreme way that there is danger of leaving in his mind the impression that all science deals with strange and remote objects. One of the criticisms of ordinary newspaper science is that it leaves in the popular mind the impression that science is full of extraordinary and mysterious problems and solutions. It would be very difficult to get any newspaper to publish some of the ordinary facts with regard to the atmosphere or with regard to the common principles of mechanics. There is no difficulty in getting a hearing for an account of some remarkable manifestation of atmospheric conditions or a description of a new and doubtful application of mechanics. Indeed, the more doubtful the veracity of the inventor in reporting his invention, the more likely is his story to get a hearing in the public mind. The teacher in the high school must, therefore, be on his guard not to stimulate the student with this foreign and strange material to such an extent that he will get the impression that science always relates to the remarkable and the remote. The student must be led to see that every object about him has characteristics which ought to arouse his inquiring mind to a scientific study.

Applications of Science constitute a Special Phase of Study

It must be admitted that the ordinary textbook on science and the ordinary class instruction fail lamentably in applying science and the scientific attitude to the ordinary facts of experience. It requires very skillful teaching to utilize physics for the ordinary facts of life. Although we are in

the midst of mechanical appliances of all sorts we overlook them so readily that the ordinary student does not see physics as a practical science; he learns it rather as a body of remote and abstract principles. The abstractness of the material is greatly increased by the selection of experimental material which has to do with interests that are ordinarily very far from the student's life. This is nowhere better illustrated than in the physical experiments which are offered as a means of instruction to girls. It has been pointed out repeatedly that the ordinary examples used in a textbook in physics are drawn from the industries that are open to boys and men rather than from the domestic surroundings which are familiar to girls. The result is that the course of physics in the ordinary high school, if made elective, is usually taken chiefly by the boys. The girls, trained through their elementary courses and through the ordinary influences of the home to disregard mechanical devices as lying outside of the sphere of woman's ordinary activities, look upon physics as a further expression of the male interest in mechanics and forget that all of the commonplace facts of ordinary life can be illuminated by a study of physical sciences. It would be very much better to begin a study of physics for girls by taking up some such problems as those of heat and color. To be sure, these are somewhat more abstract than are the laws of motion, but we shall ultimately recognize that the chief business of science, whatever its subject matter, is to train students to see problems. When we have comprehended this general principle we shall undoubtedly find that many of the sciences will have to be recast. The final form which these sciences assume for pedagogical purposes will not be the form in which the sciences are most satisfactory to the mind of the trained scientist. We must find the means of arousing in students the problem-seeking and the problem-solving attitude. We cannot depend on ordinary life to cultivate either

one of these attitudes. We must discover devices which will arouse the problem-seeking attitude, and we must then focus this attitude upon the commonplace surroundings of the students.

Textbooks present Results rather than Problems

Illustrations of what has been said in the foregoing paragraphs can be taken from any one of the science books. Most science textbooks can be criticized by drawing attention to the fact noted above that these books are chiefly concerned with the statements of results. Usually the most general results are put near the beginning of the textbook. A textbook in physics begins by telling about molecules and the constitution of matter or by giving some of the most compactly formulated statements about the principles of mechanics. From the point of view of the trained scientist this seems to be the surest way of introducing a terminology which shall be available for the statement of his science. His conception of the science is that it must follow the logical arrangement of the results of this science.

Again, let us take a textbook in physical geography as an example. We find that such a book begins with a discussion of the form of the earth. One of these texts begins as follows: "On September 6, 1522, a little company of weather-beaten sailors brought their vessel to rest in a Spanish port. Three years before, Magellan had led them forth, with a fleet of five ships, to find the Spice Islands by a western route," and so on. We have a description of the fact that the earth can be circumnavigated. The next paragraph takes up latitude and longitude and discusses the earth from that point of view. The third paragraph deals with the earth within and without. This paragraph begins as follows: "No one knows much about the inside

of our globe. Yet most of its bulk and weight are far within the surface, and geography, which looks at the earth as a whole, must take notice of it." We then have some discussion of strata of rocks and of the internal structure of the earth's crust. The fifth paragraph deals with land and water; the sixth deals with volcanoes; and so on.

Doubtless the authors of such a book as this realized to the full the importance of getting before the student some general conception of what their science is about. The authors, knowing the importance of this general conception of the earth as a whole, began by trying to give the student the ripest and most complete product of all their scientific inquiry in the first few pages. The trouble is, the student who comes to this science sees absolutely no reason why one should be so absorbed in a study of the earth as a whole. The student very seldom has any real interest in the internal anatomy of the earth. He might wonder in a general way what is there, but he certainly is not prepared to exercise his mind very vigorously on this inquiry. The scientist who is enthusiastic about some discovery regarding volcanoes assumes that every student who hears about a volcano will instantly want to know exactly how the earth behaves at these points; but the fact is that the student is usually quite complacent, knowing that somewhere in the world a scientist will furnish him with the explanation of these facts if he needs it, and, furthermore, he feels that the probabilities are in favor of his never needing the information at all.

The degree of enthusiasm of the ordinary student for these introductions which he gets in the textbooks is very slight indeed. Take textbooks on botany as another example. One well-known book on this subject opens with a paragraph on the inorganic world, contrasted in the next paragraph with the organic world. Then follow paragraphs on "the difference between plants and animals,"

a definition of botany, and a full description of the different subdivisions of physiology. Chapter II opens with a paragraph on "the course of vegetation," and so on. The student, confronted by these verbal additions to his experience, gets into the habit of thinking of science as verbal additions to experience, and he faithfully learns the words and keeps them in store against the time when the teacher demands them.

Abstract Statements of Results

If it is objected that this kind of a text is antiquated, let us take one now in common use. In its "elementary" edition it begins with protoplasm. It then tells the student about spirogyra, mucor, nitella, and the rest. The student is left to interest himself as best he can in these results of science. The instructor is at the end of the course in science; the student is at the beginning, and yet the order of presentation is that which is appropriate to the teacher's mature knowledge rather than to the student's immature state. Furthermore, these results of science come in the easy form of words. The student suddenly inherits a wealth of results without any effort on his own part beyond that which is necessary to read words. The trouble is that he has no appreciation of all this that is lavished on him. Science, from society's point of view, is a rich body of results. The scientific attitude which ought to be cultivated in the student is an inquiring attitude of mind full of problems, not solutions.

Teachers wonder sometimes why students develop an interest in science so slowly. The lack of interest is hardly to be wondered at when one has canvassed a few of the textbooks and seen how the first chapters are always very general, dealing with the results of the science and giving none of the reasons why the science should be developed.

It would be difficult for the psychologist to improve upon the efforts of the science people themselves, and it would be presumptuous to make any recommendations if it were not for the obvious failure of the current science textbooks to meet the needs of school courses. As has been pointed out time and time again, the present courses in science are under such constant criticism by the scientists themselves that any suggestion of relief will doubtless get a hearing if not a respectful acceptance.

Instruction should present Problems

Would it not be well to begin the discussion of a science in any one of the books by a concrete, particular problem as distinguished from the usual general results? Let us assume that the concrete, particular problem is approached at first in a wholly unscientific way. Let it be described from the historical point of view, explaining the interest which man has cultivated, or let it be approached from the point of view of its unusual characteristics. For example, in ordinary conversation the layman finds that the botanist has a body of information about the wheat plant which is so interesting that he wonders why this has not been put in the first chapter of some botany textbook. The answer of the scientist is, of course, that the wheat plant is by no means a suitable object for an introductory study. It does not exhibit the organs of a plant in that form which makes it easy to base upon it a later analysis of other plants and their organs. The attitude of the psychologist and the layman in science is that the textbooks which begin with the forms of plant life that are easy to expound do not seem to have succeeded, after many years, in arousing high-school students to a satisfactory pitch of enthusiasm for botany. Why not, for the sake of experiment, try something new?

Laboratory Method of Instruction

No study of science courses would be complete without full recognition of the enormous contribution which has been made to the intellectual life of students by the introduction of laboratory courses. Scarcely a generation has passed since laboratory exercises were first introduced into the high-school curriculum, and in this short period their usefulness as instruments of instruction has been so completely demonstrated that any new method in the humanities as well as in the sciences needs only to call itself a laboratory method to be sure of a respectful hearing. A well-organized laboratory exercise does for the student much that the general textbook, overfull of results, fails to do. The laboratory exercise confronts the student with a problem; it leaves him to work out the solution; it gives him an opportunity to verify his judgments. It is concrete; it shows by many of its obvious, external characteristics its relation to ordinary life.

How, then, can the laboratory method ever fail? The answer to this question is implied in the directions offered by one experienced teacher in his chapter on Instruction in the Laboratory.[1] The directions much abbreviated are as follows:

> First, the object of the experiment must be definitely stated. ... Second, the apparatus must be lucidly described. ... Third, a minute and practical description of the materials must be given. ... Fourth, the handling of the material and apparatus must be made clear.... Fifth, the point at which a pertinent observation may be made should be indicated. ... Sixth, some indication is necessary as to what is to be observed. ... Finally, definite questions should be asked in regard to the interpretation of what has been observed.

[1] A. Smith and E. H. Hall, The Teaching of Chemistry and Physics in Secondary Schools, chap. iv. Longmans, Green, & Co., 1910.

Psychology of Laboratory Exercises

Put into psychological terms these directions mean something like this: The laboratory situation is usually too complex for the immature student to master if left to his own devices. The experience of the race must be focused for him on this complex situation. He must be led by a short path to the productive conclusion which science has reached as its final result. Unless the guidance of the race is given to the student, he will wander and either come to the goal far too slowly or not at all.

Laboratory exercises are among the most difficult problems for the teacher to work out. The student must be guided enough, but not too much. The student must be called on to find out for himself, but he must not be left to become confused. The business of the teacher is to help the student reach a result, but at the same time to make sure that the student has used the right methods in reaching the result. The problem is therefore to find a proper balance between instruction and independence.

Here, as in other school exercises which are properly organized, the contrast between an educational situation and a situation in the practical world can be described by saying that the school simplifies the situation for the time being in order that the student who is limited in his capabilities may cope with this simplified group of conditions. Little by little the school must lead the student forward through more and more complex situations until finally he is able to cope with the natural environment in all of its complexity. The problem of the school is so to simplify the educational exercise that it shall train the student without making him unable or afraid to face complexities. The danger in these exercises is that they will become quite as formal and ineffective as the recitations which they were intended to supplement.

Pearson on Scientific Method

There is one final matter to be discussed in this study of the psychology of science. It is the nature of that highest product of scientific education, scientific method. Every teacher of science hopes to inculcate into his students respect for methods of exact, impersonal, and comprehensive thinking. These methods have often been declared to be the most significant contribution of our age to the history of civilization.

What, then, is the nature of scientific method? An answer to this question may be sought first in a series of quotations from the writing of Karl Pearson.[1]

The classification of facts and the formation of absolute judgments upon the basis of this classification — judgments independent of the idiosyncrasies of the individual mind — is peculiarly the *scope and method of modern science.* The scientific man has above all things to aim at self-elimination in his judgments, to provide an argument which is as true for each individual mind as for his own. *The classification of facts, the recognition of their sequence and relative significance is the function of science,* and the habit of forming a judgment upon these facts unbiased by personal feeling is characteristic of what we shall term the scientific frame of mind. (P. 7.)

The insight into method and the habit of dispassionate investigation which follow from acquaintance with the scientific classification of even some small range of natural facts, give the mind an invaluable power of dealing with many other classes of facts as the occasion arises. The patient and persistent study of some one branch of natural science is even at the present time within the reach of many. In some branches a few hours' study a week, if carried on earnestly for two or three years, would be not only sufficient to give a thorough insight into scientific method, but would also enable the student to become a careful observer and possibly an original investigator in his

[1] The Grammar of Science. Charles Scribner's Sons, 1892.

chosen field, thus adding a new delight and a new enthusiasm to his life. The importance of a just appreciation of scientific method is so great, that I think the state may be reasonably called upon to place instruction in pure science within the reach of all its citizens. (P. 8.)

SCIENCE DEPENDS ON IMAGINATION

But, none the less, disciplined imagination has been at the bottom of all great scientific discoveries. All great scientists have, in a certain sense, been great artists; the man with no imagination may collect facts, but he cannot make great discoveries. If I were compelled to name the Englishmen who during our generation have had the widest imaginations and exercised them most beneficially, I think I should put the novelists and poets on one side and say Michael Faraday and Charles Darwin. Now it is very needful to understand the exact part imagination plays in pure science. We can, perhaps, best achieve this result by considering the following proposition: Pure science has a further strong claim upon us on account of the exercise it gives to the imaginative faculties and the gratification it provides for the æsthetic judgment. The exact meaning of the terms "scientific fact" and "scientific law" will be considered in later chapters, but for the present let us suppose an elaborate classification of such facts has been made, and their relationships and sequences carefully traced. What is the next stage in the process of scientific investigation? Undoubtedly it is the use of the imagination. The discovery of some single statement, some brief *formula* from which the whole group of facts is seen to flow, is the work not of the mere cataloguer, but of the man endowed with creative imagination. The single statement, the brief formula, the words of which replace in our minds a wide range of relationships between isolated phenomena, is what we term a scientific *law*. Such a law, relieving our memory from the burden of individual sequences, enables us, with the minimum of intellectual fatigue, to grasp a vast complexity of natural or social phenomena. The discovery of law is therefore the peculiar function of the creative imagination. (P. 37.)

The scientific method is marked by the following features: (*a*) careful and accurate classification of facts and observation of their correlation and sequence; (*b*) the discovery of scientific laws by aid of the creative imagination; (*c*) self-criticism and the final touchstone of equal validity for all normally constituted minds. (P. 45.)

SCIENTIFIC LAW A PRODUCT OF INTELLIGENCE

The other problem with which we are concerned is the existence or non-existence of a scientific law before it has been postulated. Here the reader will feel inclined to remark: "Admitted that 'Nature' is conditioned by man's perceptive faculty, surely the sequences of man's perceptions follow the same law whether man has formulated that law in words or not? The law of gravitation ruled the motion of the planets ages before Newton was born." Yes and no, reader; the answer must depend on how we define our terms. The sequences involved in man's perception of the motion of the heavenly bodies were doubtless much the same to Ptolemy and Newton; to primitive man and to ourselves the motion of the sun is a common perception, but a sequence of sense-impressions is not in itself a law. That planets move, that a chick takes its origin from the egg, may be sequences of sense-impressions, they may be facts to be dealt with scientifically, but they are not laws in themselves, at least not in any useful interpretation of the word. The changes of the whole planetary system might be perceived, and even those perceptions translated into words with a fulness surpassing that of our most accurate modern observer, and yet neither the sequence of perceptions in itself nor the description involve the existence of any law. The sequence of perceptions has to be compared with other sequences, classification and generalization have to follow; conceptions and ideas, pure products of the mind, must be formed, before a description can be given of a range of sequences which, by its conciseness and comprehensiveness, is worthy of the name of scientific law.

Let it be noted that in this it is not only the process of reaching scientific law which is mental, but that the law

itself when reached involves an association of natural facts or phenomena with mental conceptions, lying quite outside the particular field of those phenomena. Without the mental conceptions the law could not be, and it only comes into existence when these mental conceptions are first associated with the phenomena. The law of gravitation is not so much the discovery by Newton of a rule guiding the motion of the planets as his invention of a method of briefly describing the sequences of sense-impressions, which we term planetary motion. He did this in terms of a purely mental conception, namely, mutual acceleration. Newton first brought the idea of mutual acceleration of a certain type into association with a certain range of phenomena, and was thus enabled to state a formula, which, by what we may term mental shorthand, resumes a vast number of observed sequences. The statement of this formula was not so much the discovery as the *creation* of the law of gravitation. A natural law is thus seen to be a *résumé* in mental shorthand, which replaces for us a lengthy description of the sequences among our sense-impressions. Law in the scientific sense is thus essentially a product of the human mind and has no meaning apart from man. It owes its existence to the creative power of his intellect. There is more meaning in the statement that man gives laws to Nature than in its converse that Nature gives laws to man. (P. 102.)

The essential conclusion which can be drawn from the psychological analysis of these statements is that science is quite as much a product of human characteristics and capacities as of the characteristics of things. The human power of reducing all objects to namable classes through the use of language is as important in explaining scientific classification as is the existence of objects themselves. Animals have no science. Their minds in contact with impressions from the outer world react in a way wholly different from that in which human beings react. Savages have a crude mythology, but no rigid scientific methods. They have no adequate scientific terminology. In short, their reactions are unscientific.

Science depends on the Power of Generalization

To the student of educational problems these considerations are important because they make it clear that science is something more than mere reception of sense-impressions. Science is a system of thought. Science is a body of generalizations. To construct this system of thought and these generalizations is a step in intellectual development beyond the mere acquisition of the impressions out of which science may grow.

We shall come back in a later chapter to the problem of the generalization of experience. This problem has come up several times before in our discussions. It is one of the major problems of education. Each subject in the curriculum seeks to develop the power of generalization in some way; and science, in making this its chief aim, is not departing in any measure from the traditions of the course of study as this course has always been organized by strong teachers, whatever the content with which they have worked.

CHAPTER XV

THE FINE ARTS

Opposition between the Fine Arts and the Conventional Courses

The fine arts, like the manual and industrial arts, have stood apart from the conventional academic subjects and have been given only a half-hearted recognition in the organization of school programs. From one point of view this is difficult to understand, for civilized nations have always regarded training in music and drawing as highly desirable accomplishments. We in America have been subjected to criticism by foreign visitors and we have freely criticized ourselves for our meager cultivation of the fine arts in our schools. While thus recognizing the arts as desirable, we have found it a very difficult problem to make them available for school purposes. How can one formulate a course in these subjects? They seem to be highly individualistic and vague in their results. There seems to be so large an element of chance in the outcome that we turn by preference to those courses of instruction which seem to be more definite and capable of impersonal formulation.

The psychology of the fine arts helps to explain in a measure this situation. The arts, like literary appreciation, depend in large measure on certain inner reactions which are obscure and often unrecognized by student and teacher. The external acts which are cultivated when one acquires some skill in one of the arts sink into insignificance as compared with the inner emotional processes involved in appreciation. These inner reactions are extraordinarily difficult

to control and train. A part of the vagueness of the arts also grows out of a lack of analysis comparable to the lack of analysis which we found in studying manual habits. When one enjoys a painting it is very difficult for him to tell why he enjoys it. When one feels a thrill in response to music he does not make the kind of analysis that he does when he distinguishes the parts of a plant in botany or the organs of an animal in physiology. The arts train in a type of analysis which we shall understand more fully as we proceed with the discussion; but this analysis is different in character from verbal analysis, and the school familiar with scientific and verbal analysis has great difficulty in taking up the problem of art analysis.

Historical Beginnings of Music

We shall gain a clearer view of the nature of art consciousness by studying briefly the evolution of one of the arts. The history of music furnishes material for such a study. One of the most primitive forms of music is that produced by the dancing warrior who beats his spear against his shield. A little higher in the evolution of the art the drummer sits apart and makes a rhythmical sound that guides the dances. The sounds in both these cases are not of interest because of their quality. In fact, the quality is of the crudest sort. The music is nothing but a crude series of noises reënforcing the bodily rhythms by giving to the nervous system shocks of stimulation which aid and intensify the rhythmical reactions.

The work-song is another primitive type of music. A group of workers set up a rhythmical vocal accompaniment to their activities. The vocal reactions are not of significance because of their quality. Even when words are used these words have no significant ideas to convey to the singers. Anyone who has listened to a group of sailors drawing in

a rope and chanting a meaningless melody will realize at once that the purpose of the song is to secure social co-operation and to emphasize a rhythm of bodily activity which turns drudgery into a pleasurable succession of stimulations and reactions.

The content of consciousness in both these cases is, of course, a matter on which one can offer only speculations. But if we may judge from the analogies of personal experience, it is safe to say that there is not much analysis of experience. The sounds and bodily activities, the rhythm and the excitement, all fuse into a vague general mass of experience which submits itself only very little, if at all, to consideration or scientific dissection.

Development does, however, gradually take place, showing that there is a tendency for attention to concentrate on the sound and for experience to become more complex in the rhythms which are evolved. The pleasure which comes with this enlargement of experience is greater than the primitive types of pleasure which came when the art was in its cruder beginnings.

Rhythm the Chief Source of Pleasure in Primitive Music

Let us consider first the increasing complexity of rhythms. Boas[1] has shown that primitive American tribes cultivate the ability to beat simultaneously two or three different rhythms with different parts of the body. These rhythms also exhibit internal complexities in that the accented movement is related to a whole series of complex, unaccented beats.

[1] Franz Boas, The Mind of Primitive Man. The Macmillan Company, 1911.

Growth of Discrimination of Tones

With the growth of complex rhythms there is a natural demand for differentiation of sounds. The accented sound differs from the unaccented in intensity. The contrast is made sharper if qualitative differences are also introduced. Thus, if the drummer has two drums or a series of sticks of different lengths and strikes these at intervals in the music, there will be a pleasing variety of pitch and intensity to accompany the complex rhythm. All this calls for increasing attention to the sound elements of experience, and the professional musicians of the tribe discovered the meaning and value of tonal differences as well as the possibilities of more complex rhythms. The analysis of these professional musicians can hardly be assumed to be paralleled by any like analysis on the part of auditors. The auditor receives a mass of experiences which he enjoys, and yet he never stops to analyze his pleasure. We discover even at this early stage, therefore, that reactions to music are highly individualistic and variable in character.

Enjoyment due to Reactions

A consideration in some detail of the internal processes on which appreciation of rhythmical sounds depends makes it clear that we are here in the presence not of a purely sensory fact but of a complex form of behavior. There is a change in the rate of the heartbeat and of respiration. There is a change in the tension of the voluntary muscles. There is a succession of contractions and relaxations of the muscles of the hand and arm and trunk. Even the crudest sounds, if rhythmical, arouse in one the impulse to beat time. In short, there is a real physical play which responds to the stimulations of the music heard. If the vocal cords are excited so as to participate in the response, the pleasure of

articulation may be added to the pleasure of other organic reactions. The conspicuous fact which is brought out by all these considerations is that enjoyment is a complex phenomenon depending in large measure on motor responses. Furthermore, each individual responds with a series of movements peculiar to himself. His past development and present nervous and muscular development determine his inner reactions. This explains the individualistic character of art and also the fact that the essence of the art is in its appeal to the individual, not in its external content.

Primitive music remains for a long period at this level where it is to be described as a mere accompaniment to bodily rhythms. The variety of tones necessary at this stage of evolution of the art is small. We find, accordingly, many musical scales which include only two or three tonal variations. A common form of primitive music is that in which the voice or musical instrument oscillates between a note of low pitch and a note of high pitch, passing from one to the other and back again in a rhythmical succession of sounds and intensities. Sometimes this scale is elaborated into three variations of pitch, sometimes into five.

Art ultimately becomes a Standardized System

Each of these changes in the scale marks an increase in the complexity of experience. The particular tones used by any particular tribe also come to be standardized. The result is that music rises to the level of a highly specialized system of tonal variations and combinations. Music as an art does not use all the variations of tone of which the voice is capable; it uses only a limited number of selected tones. Indeed, in early music the chant and the accompaniment were different in tones, thus leading to the evolution of a specialized instrumental music. Furthermore, it is to be recognized here, as in all arts, that the experience of

the auditor or observer very often does not include as much attention to detailed differences as does the experience of the producer. The auditor is absorbed in the total unanalyzed excitement of the situation.

Dependence of Art on Subjective Motives

At this point we may digress to call attention to the fact that music evolves from purely subjective motives. Art is never forced upon man by the external world. Man was compelled to learn the practical art of getting food and the practical art of building shelter because the stern necessities of existence in the world drove him to think of the things about him. He had to pick out the objects which he needed and think about them, and consequently his practical needs trained him in concentration of attention on the particular things about him. But music has purely subjective value. Music appeals to the rhythms of the body and nervous system. Music does not move the world or provide shelter. Music develops only in response to the demand for subjective delight. We find, therefore, that musical systems, when once they are evolved, are extraordinarily conservative, depending absolutely on the development of modes of reaction in the individual. Primitive races adopt the clothes and the food of civilized man, but keep their own dances and their own music. Music is pleasurable because it sets up personal reactions and responses. The more highly the art is elaborated, the more definitely personal responses will become fixed. Above all, music is not a practical system of behavior.

Returning from this digression, we note that music as a system of sound relations developed in connection with the development of song on the one hand and with the growth of technical skill in instrumentation on the other hand. As the chanting of the minstrel at the festival and later as

the singing of the church choir developed, more complex systems of tonal combinations were worked out. Attention was centered in these later stages on sound, and the combinations of sounds constituted a growing part of the art. The development of interest in sounds was also accompanied by an evolution in the mechanical devices for the production of tones, though instrumentation has in many respects shown lines of development different from those which appear in vocal music.

Melody and Harmony related to Reactions

The evolution of tonal discrimination and interest in tonal combination carries us far beyond the original stage of music, where the interest attached merely to noise and rhythm. As soon as men began to discriminate tones, they were led to work out certain regular sequences, or melodies. Later these melodies were made increasingly complex, until finally the higher forms of harmony were evolved.

These later forms of experience seem at first observation to be sensory matters, and psychological discussions have usually proceeded on the theory that appreciation of melody and harmony is a sensory fact. The physicists, concentrating attention upon the stimulus which comes to the ear, are able to show that the number of vibrations in the successive tones included in an agreeable melody stand in a definite numerical ratio to each other. This fact has in turn been accounted for by certain physiologists as due to certain structures in the ear. The discussions which have been carried on in support of these sensory theories cannot appropriately be reviewed in detail here. We may remark in passing, however, that there has always been great difficulty in working out a satisfactory theory of the sensory elements involved in the creation of a scale and the development of melody.

It is legitimate to supplement these sensory theories by turning to the motor processes. A nation, long accustomed to a certain scale of sounds, cultivates both in singing and in emotional responses a definite set of reactions, which are aroused when one hears music or when one attempts to produce melodies or harmonies. These facts of response are quite as significant in explaining appreciation as are any facts of sensation.

The case is immediately clear if we refer to the appreciation exhibited by a trained singer. Whether he listens or himself sings, his appreciation of tonal differences and of tonal conventions will depend upon the ability of his vocal cords to produce by a muscular readjustment the successive pitches of the melody. Where the adjustment of the vocal cords in attempting to pass from one tone to another is of an extremely difficult type, as for example when the tones are too nearly alike, the reaction will be difficult and disturbing. The flatting of a tone either when one is singing or listening is an extremely painful experience for a trained singer, because he realizes, not only through his ear but also through his own motor adjustments, that the flatting of the tone is an improper adjustment of the sound-producing organs. When, on the other hand, the movements of the vocal cords are easy and agreeable, the total emotional experience is one of great pleasure.

Added to these habits of the vocal cords, however, are the trained reactions of all the emotional reactions which come through long drill in a conventional series of pitches accepted in the national musical scale. A Chinaman evidently enjoys the monotonous succession of simple tonal variations which make up his national music. A European enjoys the simple Chinese music very little. He has been trained to a more elaborate series. In either case it is not alone the ear that has been trained. The whole organism responds to melody.

This view finds new support in the fact that appreciation of harmony comes late in the evolution of music. Harmony consists in a group of agreeable simultaneous tones. The tones which are agreeable when heard simultaneously are for the most part those which are agreeable in a succession of tones. The development of a taste for harmony is a relatively recent fact and its psychological explanation is most intricate. One may discuss contrasts in tones and the fusion of tones; one must recognize that inharmonious tones produce beats and roughness which are added items of sensation, distracting from the pure tones and disturbing recognition; but after attention has been given to all these sensory elements of harmony the fact remains that there is an inner emotional response to all harmony, and this response is not a sensory element. When one listens to a great orchestra his appreciation is determined not alone by the way the sound strikes the ear; it is the reverberation of the whole muscular organism that explains the enjoyment.

Appreciation increased through Training in Production

Consider the child who is learning to sing or play the piano. Observe how this child makes keener discrimination after a little practice; note that he listens to melodies with new appreciation. In fact, the full appreciation of music cannot come without some skill in production. Some appreciation of music there is without a corresponding ability to produce, but the auditor's appreciation is never so complete as that of the person trained in production. Even the appreciation exhibited by the mere auditor must be explained in motor terms. The relaxation which comes when one hears rich, soft tones, the tightening up of the muscles when one listens to martial music — these are typical facts on which to base an understanding of the appreciation.

When one has, in addition to the vague general organic reactions just mentioned, the finer discriminating reactions of the trained technician, appreciation will be of a higher and more complete type. Nearly every one can tell when a note is very flat, because every one has some skill in the vocal production of simple melodies; but it requires the trained singer to recognize a slight departure from the exact note. So it is with the more elaborate emotional responses to musical combinations.

Variety in Attitudes toward Music

The complexity of the educational problem becomes obvious when we summarize what has been said about different classes of persons, all of whom are involved in this discussion. Consider in succession the composer of melodies, the ordinary producer, and the auditor who enjoys music but is not trained in production. The composer studies the laws of musical relations and the effects of various combinations of tones. His attention is alert for tonal differences and effects. The producer may be a pure technician, translating visual symbols or memories into finger movement, or he may add varying degrees of discrimination. The listener may respond merely with vague general bodily reactions. The practical school problem is to train all students to some extent, and to discover the possible producers and composers soon enough to give them the more elaborate training which they need.

Germany has a universal system of training. The pupils in German schools are taught to sing. The teachers of the *Volksschule* are trained to give instruction in music by courses in instrumental and vocal music. Every such teacher must sing and play either the violin or the organ. Appreciation is thus developed by a course of training in the production of music.

In the schools of this country music is regarded as desirable enough to be made a part of the course; training in singing is the method most commonly adopted of cultivating appreciation. Instrumental training is seldom taught. In a few instances the theory of harmony is taught even to secondary students. For the most part, however, training in music is regarded as a luxury, and failure to show efficiency in the music course is not treated as a serious deficiency.

Especially has the cultivation of skill in playing a musical instrument been looked on as of doubtful educational import. The experience of the world has shown that in some conspicuous cases the instrumentalist is devoid of intellectual power of the ordinary types; skepticism has therefore arisen as to the value of instrumental practice as a means of general training. This skepticism regarding instrumental music has reënforced the general attitude which arises from the fact that music is different from science and history and literature, and has made it more difficult for music to secure a place in the curriculum.

Problems of Instruction in Music

If one asks the music teacher what is cultivated in students by the course in music, the answer received is likely to be somewhat hazy. Some statement about the higher emotions, about cultivated feelings, is as far as one usually gets in these discussions. The psychologist has a right to ask that the emotion be defined more fully. Here we encounter the real difficulty. The various individual modes of appreciating music are so different that the work is extraordinarily difficult to standardize. One person appreciates music because he has learned to play the violin, another because he has learned to sing, another because music sets his involuntary muscles in emotional action. Each person enjoys music, but each in his own way and in

his own degree. Suppose the problem is put in such terms as these: "Does it pay to take two hours a week to train students in singing?" There are two kinds of results from such training. The students will learn in some degree to sing. This result can be observed and tested. If the two hours a week have to be given for what is usually accomplished in singing in a high-school class, the investment is probably too heavy. The music teacher will, however, usually emphasize a second and not easily measured result. The singing may be poor, he will tell you, but the cultivation of taste is the real result. If now you ask for the evidence of cultivation of taste, it will be very difficult to supply objective evidence. This is the major reason why music and the other arts are looked on as doubtful members of the academic family.

There is another phase of the situation which is not to be overlooked. The lack of analysis which is usually exhibited in the experience of a person who is absorbed in music is so opposed to all of the traditions of academic training that teachers are skeptical of the mental attitude which grows up through interest in music. To be absorbed in tonal combinations, to react with strong emotional reactions, may be personally satisfying and even elevating, but the scientific, analytical mode of looking at the world is the end aimed at in most of the other classes in the school. The analytical attitude teachers understand, and they know that this is the sort of training of attention which lies back of many improvements in our modern civilization. Music, they hold, will have to prove its case, if it has a case, or it will have to remain an incidental feature of the curriculum.

To introduce some history of music or some studies in harmony, in the hope of turning music into a subject like other subjects, is probably not the way to prove the case for music. To present general statements about the elevating

effects of music is certainly not the way to prove the case for music. To give drill in production, together with training in some of the canons of the art, and to concentrate attention on good examples of music so as to cultivate genuine appreciation are probably the most promising methods of procedure. In the meantime, someone interested ought to give to the students of education a statement of what musical taste really consists in, and he should evolve some method of evaluating the effects produced by instruction.

Graphic Art as an Instrument of Instruction

What has been said with regard to music may be repeated, with slight variations, for the graphic arts. If we study the history of graphic arts, we find again a rapid process of differentiation between the producer of pictures and the person who merely enjoys pictures. The producer of pictures, like the producer of music, has been regarded by society as a person whose skill is to be respected. Certain aspects of the skill exhibited by the producer of drawings are recognized as of the highest intellectual type. The civilized world has commonly been prepared to reward its producers of art. On the other hand, the appreciation of a drawing is another matter. To give academic credit or any other form of credit for ability to enjoy a picture has not in general been regarded as legitimate. Furthermore, it has sometimes been doubted whether the school ought to try to cultivate in any general way the technical ability needed to produce drawings. It has been pointed out that some people apparently acquire this ability to produce drawings by some mysterious process of inheritance, or by a special devotion to one aspect of mental life to such an extent that they become narrow specialists, and defeat, through their devotion to graphic art, the ordinary ends of intellectual training. A person who is always trying to draw things may be very

negligent of his social relations and of his relation to the physical necessities of life. The artistic temperament, as it is sometimes described, is looked upon by the practical man, when it assumes its extreme form, as an unfortunate type of intellectual development, and one which hardly fits into the general scheme of society's life and society's training. There is, therefore, a great deal of confusion in the minds of school officers as to what they ought to do.

Technical Character of Drawing

Again the psychologist comes forward with the suggestion that a more careful study be made of the mental processes aroused by the study and production of drawings. The historical materials are even more definite than those available in music. On the other hand, the reactions which arise in the individual are more heterogeneous than are the reactions which result from appreciation of music. Appreciation of pictures is connected in a measure with the observer's development of space percepts. This involves, as indicated in an earlier chapter, some appreciation of mechanical balance. For these and like reasons we must relate graphic art to both the fine arts and practical behavior. Indeed, the pictorial arts are much more closely related to the industrial arts than music, for the simple reason that the pictorial arts have been obliged to employ external materials. There is no form of behavior which will produce a picture without the manipulation of external materials. In this respect drawing differs from music, since the unaided voice will produce music. A picture is always dependent upon the relation between a tool of some kind and the substance on which the picture is drawn. To learn the relation between the tool and the surface on which the picture is to be produced involves, therefore, the acquisition of a technical art. Furthermore, the subject of every

pictorial expression must be some external object. Consequently the artist is obliged in the drawing of his picture to pay some attention to the things which he intends to represent. There is in this necessity of paying attention to the external object an important characteristic of graphic art.

Early Disregard of Pattern

The extent to which the external object enters into drawings is a matter of great historical interest. We find, for example, that in earlier art the color of objects is a subject of very little attention. Indeed, there was in the early days of painting so obvious a conflict between the observations which were made on external objects and the materials which were in the hands of the artist for expression, that it was only by neglecting the color of external objects that the artist could do anything. He had no means of expressing the observed colors of nature. The artist took advantage of the fact that the ordinary observer pays so little attention to color that it is usually quite impossible for him to give any account of the different shades of color exhibited by the object which he has in memory. Primitive painting was very like memory images in the fact that it did not imitate natural colors. What colors the artist had he used in expressing certain distinctions which were in his own mind. Color was of value, therefore, merely as a means of drawing attention to certain sharp contrasts. We find, accordingly, in primitive art a period of purely symbolical use of the color differences; and, furthermore, these colors were put into the pictures not in the relations in which colors appear in natural objects, where gradations of color and modulations of color tone are the rule, but in the earlier pictures there are great surfaces of the most striking colors, contrasted sharply, without gradations.

Defective Perspective in Early Drawing

Another conspicuous lack in primitive drawing is a lack of perspective. The early artists were again dominated in their productions not by a careful examination of the objects which they represented but rather by their own memory images. It makes no difference in the memory images whether an object is regarded as far away or near at hand. Its essential character is the same in either case. Indeed, the considerations which determine the size of objects in memory are wholly different from considerations of distance. It is the important objects which are likely to loom large. Important objects may be so large as to be altogether out of proportion in thought to the other objects, which constitute the background of consciousness. We see, therefore, in earlier art grótesque exhibitions of disregard for the true relations of perspective. In the foreground of the picture will appear a human figure of colossal size as compared with the landscape, which is put behind for the sake of artistic completeness. In like fashion, the impression which the earlier artist had of the interior of a room was very primitive indeed. Under the ordinary conditions of life one does not concentrate attention on the spatial characteristics of the room in which he lives. For example, one does not recognize the details of the lighting of the room until he has made a very careful study of it. Consequently the earlier artists were altogether unable to represent the interior of a room or to give the objects in the room anything like their real shading.

This difficulty of representing perspective properly appears very conspicuously in certain mistakes made both by children and by primitive artists. In drawing a human figure in profile a child will represent more in this profile than he could actually see in an object observed from the side. He puts both eyes on the side of the face, or he represents

both arms on the side of the body which he is trying to draw. Primitive artists did exactly the same sort of thing. Furthermore, primitive artists and children draw the different parts of objects out of all proportion to each other. They draw the head of an animal altogether too large. This is due to the fact that the head is of much more significance to the observer than is any other part of the body.

Complex Psychological Character of Graphic Art

All of these facts with regard to primitive art and children's drawing show that the graphic arts are a mixture of internal motives springing from the artist's memory and from his personal attitudes toward objects and external motives borrowed more or less skillfully from the world of sensory experiences. For the most part, it may be said that attention to the external objects is relatively very late, and a careful analysis of external objects is the result of very elaborate study.

This statement is seen to be the more significant when it is remembered that a large part of art is to be classified as design rather than as pictorial representation of objects. Design calls for the distribution of the drawing in a given space, and that space must, furthermore, have the different parts of the drawing so distributed as to satisfy the fundamental demands for symmetry and balance. Much of the appreciation which we have for mural decoration is due not merely to the representations of external objects which appear on these surfaces, but to the way in which these representations are grouped so as to satisfy the observer with the space in which the drawing is placed. The lines of a mural painting must tend to support the architectural structure, and the emphasis which is given to different parts of space must have due regard to the building as well as to the thing depicted. Frequently the demands of

design are such as to supersede altogether the interest in the representation.

Where design flourishes, therefore, there is developed a kind of taste which is wholly different from that which attaches to the study of objects. For example, in dress designs and in decorative patterns on fabrics, taste depends on form relations, not on the desire to represent any real objects.

All these facts complicate the issue for the school. Shall students be taught to draw? If so, what is the motive? Study of form and color? Appreciation of symmetry and balance? Careful observation of things or a study of the properties of expressive materials?

Appreciation More Complicated than Production

If there is difficulty in dealing with graphic art as a means of educating those who produce pictures, the difficulties multiply when we discuss the training of appreciation apart from production. Let us consider a concrete case which shows how difficult is the training of appreciation. A painting which tells a story will usually excite infinitely more popular enthusiasm than a painting which shows the finest balance of form and color. The reason for this public enjoyment of the story-picture is that this picture arouses familiar, responsive emotional reactions. The painting shows someone in danger; the observer has all the contractions which would come from seeing real danger, with this one qualification, he knows that no harm is really coming to the subject represented. So he can enjoy the thrill of real danger without having to pay the price of a real catastrophe. His experience is accordingly intense, while the cost is small.

Yet pictured stories are not the highest art we are told. One ought to rise through training above the primitive enjoyment of a picture which merely tells a story to a correct

appreciation of the highest art. This higher art is sometimes called in question. One finds himself interposing the objection that art has often suffered in its extreme technical forms from temporary domination by grotesque fashions. How is one to be sure that the refinements which his taste undergoes are really carrying him in the direction of the highest types of appreciation? Perhaps he is taking on an artificial fad. The very fact that appreciation is a subjective matter, not checked by external conditions, leaves art at a disadvantage when contrasted with science. Science checks subjective reactions by constant references to the world of things. Art cannot check itself in this way. The fact that Western art exhibits fashions so radically different from those of the Orient, and the fact that occidental art shows so many divergent types in our own times, shows the difficulty of using art as an instrument of general education.

Comparative Values of Different Forms of Appreciation

It has been pointed out that literary appreciation is accepted in the schools without serious dissent, and it is asked why art of other types should be less hospitably received. The answer is not far to seek. Language is a mode of expression which all must cultivate for the purposes of practical life, while the other modes of artistic expression are relatively nonessential. Since all must cultivate language, all will have some of the producer's share of appreciation in artistic language forms. Furthermore, the canons of taste in language are constantly checked by the applications of language to the practical affairs of social and personal life. There is, accordingly, a stability in the language arts which does not appear in the other arts.

The reader of the foregoing pages will doubtless interpret what has been said as unfavorable to the introduction of

art into the high-school course. Such an interpretation is legitimate only in so far as difficulties frankly faced always seem to make the case unfavorable. The writer might free himself from the responsibility of uttering criticism against art by hiding behind the actual present-day verdict of the schools. If he has implied criticism of art, the school openly classifies art as of doubtful value in the course of study. It is no part of the writer's purpose to escape responsibility by appealing to present practices and present prejudices. He much prefers to let the statements stand as valid quite apart from any of the present attitudes of those who make school programs. The interpretation which he would put upon the facts discussed is this: If the arts are to find a place in the school program, they must first find an adequate and definable method of instruction. Experience seems to point in the direction of an emphasis on production as the best method of training. Whatever the method of instruction, art teachers must give up the practice of indulging in rhapsodies over art and its value, and must learn to define the types of appreciation which they wish to cultivate. They must show that they know when they have produced one of these approved types of appreciation. Finally, they must by practical demonstration convince the world that there is no fundamental opposition between the habits of mind and action cultivated in the arts and those cultivated in the scientific courses given in the schools. The present-day conditions are a challenge to art teachers and to all of us. Vaguely we all believe in art; practically we are not able to bring it into the schools in any form which we regard as satisfactory for the training of students. To bring it forcibly into the course without heeding the objections raised will be unfortunate. To omit it altogether is to deprive the student of one important aspect of civilization. The challenge to deal with this situation intelligently is peremptory.

The Present Status of Music in American High Schools

Since the foregoing statement has given relatively little account of the practices of high schools in the matter of art instruction, we may, before closing the chapter, make some reference to the reports which show the conditions of these lines of work in schools.

Statements with regard to music may be taken from a bulletin issued by the Bureau of Education.[1] The following quotations taken from different parts of the monograph set forth the situation in detail.

Musicians are not fully agreed among themselves as to what constitutes music education. The definition still varies according to the standpoint of the definer. The composer, the performer, the theorist, the pedagogue, will each interpret it in the light of his own specialty. It is this lack of system, this indefiniteness of aim, that have repelled those who mold educational opinion, and have caused them to withhold from music that educational value which its votarists claim for it but which has been obscured by the desultory nature of music instruction. (P. 7.)

A statement of the work in secondary schools would be a recapitulation of what has already been said [regarding courses in colleges and special schools of music] with the addition that the standards of excellence and efficiency do not as a rule compare favorably with those in the institutions of higher education. Of the two hundred and twenty-eight schools reported forty-six per cent employ one or two instructors whose entire time is given to the institution and whose duties are to give instruction in piano, singing, organ, violin, and theory. There are schools among the number reported which have well-organized departments and well-conceived courses of study. In some, mention is made of the advantages accruing from the study of music in connection with subjects in the literary departments,

[1] A. L. Manchester, "Music Education in the United States," *Bulletin No. 4* of the United States Bureau of Education, 1908. Whole number, 387.

and in a few instances, the completion of a high-school course of at least three years is required before graduation in music. Attention here, as in many institutions of the other classes, is directed mainly to performance, with some emphasis upon theoretical subjects. (P. 19.)

Perhaps no single disclosure by the investigation is more encouraging than this. While the advancement of students still rests in many cases with the instructor, or with the instructor and director of the department jointly, the development of a system of accurate grade marks, based on examination and recitation, gives promise of the eventual setting up of such standards as will result in the unifying of educational effort. (P. 41.)

There appears to be a growing purpose upon the part of the departments of music in colleges and universities to demand a certain amount of general educational qualifications from those who wish to enter graduate courses in music. (P. 42.)

Perhaps the most significant fact which an investigation of present tendencies shows is the marked change in their attitude toward music of the dominating forces in educational movements to-day, namely, the colleges and universities. While music is still made to feel that it is only tolerated in some institutions, there has come to pass what might rightfully be esteemed a remarkable change of heart upon the part of the institutions of the highest grade and influence. It is clear that the separation between music and general educational thought is not only being rapidly lessened but that it will completely disappear in a much shorter time than past conditions would warrant one in predicting. (P. 81.)

Secondary schools, which in general education take care to have their courses closely articulated with those of institutions of higher education, attempt the same grade of music instruction as the best equipped conservatory or college. There are no secondary music schools. A well-defined, properly regulated development of music education from its most elementary to its highest grades does not yet exist. (P. 83.)

Carter on Graphic Arts in American High Schools

A review of the place of graphic arts in secondary schools in the United States is included in the general volume prepared under the auspices of the American Committee of the Third International Congress for the Development of Drawing and Art Teaching held in London in 1908.[1]

In his review, Mr. Carter gives various statements made by heads of departments in high schools regarding the purpose of art in the secondary-school course. In summing up these various statements Mr. Carter writes as follows:

Increasing importance seems to be given to the dissemination of art ideas. We are recognizing more and more that familiarity with these ideas is fully as important as technical skill in drawing and painting. It is also to be noted that the tendency is increasing to connect designing with work in material. (P. 206.)

Most of the teachers have had special training. Occasionally they have studied at home and abroad with the aim of becoming artists, and have afterwards taken up teaching. As a general thing they are allowed considerable liberty as to what they teach and as to how they present it. As a consequence courses of study present considerable variety. (P. 209.)

A Psychological Investigation

In the field of graphic art many studies have been made of children's drawing, but these relate, for the most part, to an earlier period than that in which we are interested in dealing with the high school. One volume, however, which may be referred to as a strictly psychological discussion is De Boisbaudran's monograph entitled, "The Training of

[1] Charles M. Carter, "Art Education in the High Schools," in Art Education in the Public Schools of the United States (edited by J. P. Haney), pp. 201–242. Published by the *American Annual*, New York, 1908.

the Memory in Art."[1] In this monograph the author gives an account of his method of training students to remember form and color. The whole discussion is very interesting to the psychologist in its emphasis upon the analyses which are to be made of objects, in order that the student may be keen in his memory of their outlines and colors. The volume is a very forcible argument for the kind of analysis described in the paragraphs in the foregoing chapter on the place of drawing in science instruction.

Dow on the Teaching of Art

In support of some of the comments which have been made regarding the difficulty of defining the exact purpose and character of art instruction it may be proper to quote at length the hopeful but vague statements of one of the leading teachers of the graphic arts.[2]

A training that calls for a very direct exercise of the critical powers, developing judgment and skill, is a training that will increase the individual's efficiency whatever his calling may be

The general public has not thought of art education in this way, but has acknowledged the value of "drawing," especially when it can serve some utilitarian purpose.

A better understanding of the true usefulness of art recognizes creative power as a divine gift, the natural endowment of every human soul, showing itself at first in the form that we call appreciation. This appreciation leads a certain number to produce actual works of art, greater or lesser, — perhaps a temple, perhaps only a cup, — but it leads the majority to desire finer form and more harmony of tone and color in surroundings and things for daily use. It is the individual's right to have full control of these powers.

[1] Translated from the French by L. D. Luard. The Macmillan Company, 1911.

[2] A. W. Dow, "Theory and Practice of Teaching Art." Published by Teachers College as a reprint, with additional plates from *Teachers College Record*, 1908, Vol. IX, No. 3, p. 1.

Even from the economic side, that education is deficient which leaves one unable to judge of form and color when he is constantly required to use such judgment. This lack of appreciation is responsible for an immense waste of labor, skill, and money in the production of useless and ugly things. Works of fine art stand among the things which the world prizes most highly. A nation's ideals are revealed in its art, and its art has greatest value when it is the expression of the spirit of the whole people.

In a sympathetic public is found the life-giving influence which creates works of fine art, and the measure of their excellence is the measure of the nation's appreciation.

The attainment of such an end as this places public art education above a mere training in drawing, painting or modeling, and above the so-called practical applications. The work must be organized for a steady growth in good judgment as to form, tone, and color, through all grades from the kindergarten to the university. The main question at all stages is whether the art work of the school is making this good red blood of appreciation and giving to the individual the greatest possible encouragement to express himself.

CHAPTER XVI

HISTORY

The Rapid Increase of History Courses

History courses have grown very rapidly in recent years, both in the number of courses offered and in student registration. While the courses in science have grown relatively less popular, and while the subjects which were formerly required of every student, such as mathematics and classics, have been falling off, history has steadily gained. There is evidently a general belief on the part of school authorities and students alike that history serves, in a very important way, the interests of broad, general education.

During the period of rapid growth of historical subjects there have arisen many questions both as to the subject matter and methods. The reports of successive committees of the American Historical Association, and of certain local associations which have interested themselves in the organization of a secondary course, all make it clear that a definition of history is more difficult than a definition of almost any other subject in the curriculum. The types of judgment which history is supposed to cultivate in the student and the wide range of facts which are given to him in the history courses distinguish this subject from the other subjects of the curriculum. The only other subject which approaches history in the complexity and range of material is English, and, as we have seen in an earlier discussion, it is extremely difficult to organize the English courses satisfactorily just because of the variety of ends which different teachers seek to attain through them.

Administrative Complication in organizing History

One becomes clearly conscious of the difficulty of defining history if he examines the various suggestions which have been made about sequences of courses, and even more if he examines the actual practices in schools. The actual practices depart from the ideal courses which are laid down by committees of historians, because students do not take the full series of electives that are regarded as necessary by the authors of these plans for a complete course in history. The ideal course is sometimes based upon a chronological sequence. Ancient history is to be followed by medieval and modern European history. These, in turn, are to be followed by the special study of English history and by a final course in American history. This full chronological plan, however, is not organized so that all of its parts can be taken by each student. The student in the classical course is sure to be required to take ancient history. Whether he takes any other history or not depends entirely upon the opportunities which the elective course may offer him and upon his ability to take advantage of these opportunities at the same time that he is fulfilling the requirements of the college which he expects to attend. We have in many cases, accordingly, the spectacle of a classical student thoroughly trained in ancient history but relatively ignorant of any of the modern periods. On the other hand, the student who takes one of the modern-language courses, or who takes a scientific course, very frequently is content to elect only a single modern-history course out of the chronological sequence. In some states the single course which such a student takes is determined by law. A course in American history is required of every graduate of the high school; and this is the only course in history which many students are able to include in their programs.

Here again a complication grows out of the fact that American history is one of the favorite subjects of instruction in the upper grades of the elementary school. It is not regarded as advisable, therefore, to include it in the program of the earlier years of the high-school course. The student takes American history in such cases near the end of his high-school course, but without any background of European history or any knowledge of the English antecedents of American civilization.

The Variety of Purposes aimed at by History Courses

Not only is the history course thus broken up by the miscellaneous choices made by students, but the courses themselves seldom show any clear definition of purpose or progression of method. In writing for Monroe's "Cyclopedia of Education"[1] Professor Haskins defines the proper sequence of historical courses as follows:

> In the earlier stages of historical instruction, attention is given particularly to the teaching of a few simple facts and the development of the historical imagination; in the higher stages the number of facts increases and more emphasis is put upon their relations and political and social significance, and upon the acquisition of a critical and impartial habit of mind; while in the most advanced grades of instruction the student learns to find, test, and combine his facts for himself until he is able to undertake independent research.

The Difficulty of organizing Coherent Courses

This definition of the proper sequence of historical methods and material is, however, seldom realized in the actual practices of high schools. Indeed, it may be doubted

[1] Vol. III, p. 284. The Macmillan Company, 1912.

whether even in college departments of history a definite sequence of this sort is ever followed. It is not an unfamiliar experience of the student to find that the course in history which he pursues in his senior year is no more advanced in character than the course which he takes in his freshman year. The subject matter has, indeed, changed somewhat; it may in some cases be more detailed in the later course than in the early course; but there is no obvious progress from year to year in the intellectual requirements which are made in the successive history courses.

In this respect history is in sharp contrast with many of the other subjects in the curriculum. The course in Latin or the course in mathematics carries the student forward to more and more complicated mental operations with each change in the subject matter. Science, as we have pointed out, does not show us clearly this progressive demand upon the student in successive courses. That is a symptom of immaturity in science teaching as well as in the organization of the history courses.

The lack of sequence grows in part out of the fact that any course in history may make, and does make, a very large demand upon the general powers of the student. Even if a student is studying the relatively simple material of biography, he has an opportunity to judge of all sorts of human relations in a complex fashion which makes the subject of history from the outset very broad in its character and in the types of mental activity which it should include.

Hart on the Purpose of History Courses

It is not difficult to find evidence that historians themselves recognize the complexity of history. A number of quotations may be given to show the extent to which they have pointed out this complexity of their subject. In the

following statement Professor Hart[1] indicates a number of different intellectual methods of procedure which a good history course ought to include. Especial emphasis should be laid upon the latter part of Professor Hart's statement, where he demands more than mere accumulation of facts.

Let us now pass to the everyday work of the classroom. In all historical teaching the first principle to fix in the mind of pupil and teacher is the importance of accurately established facts, and the second principle is the worthlessness of detached facts. From the beginning, it should be understood that a knowledge of facts is not a knowledge of history; that the textbook simply selects and groups a very small number of facts, and that the essential thing is to know how facts are related and what they mean when viewed together. There are, therefore, four correlated aims which the teacher must keep constantly in mind. He must teach facts; and for that purpose the textbook and recitation system is best adapted. He must show the relations between facts; and lectures and talks will bring out those relations. He must accustom the pupil to assemble facts for himself and to test them; the topical method affords the necessary training. He must lead the pupil to think and judge a little for himself; the preparation of topics and outside reading will induce some degree of independent thought.

The Committee of Five on the Purpose of History Courses

The Committee of Five, which has recently reviewed the work of earlier committees and expressed a very mature judgment upon the proper character of historical work in the secondary schools, describes the course in history in the following terms, making clear its general position that the scope of such a course is very broad.[2]

[1] History in High and Preparatory Schools. Reprinted from *The Academy* for September and October, 1887, p. 14.

[2] The Study of History in Secondary Schools. Report of the Committee of Five, p. 14. The Macmillan Company, 1912.

But if history is to be a study of actual educational value and culture, if the boy and girl are to be given insight into social life, some real sense of time and movement, and, above all, interest, vital interest, in books and facts, the teacher must have character, enthusiasm, and knowledge. Because we believe so profoundly in the helpfulness of historical study, the necessity of bringing the pupils to see the world about them as the product of past ages, the value of learning to handle books and to think and speak clearly, — not alone of quantities in algebra or of facts in physics, but of human doings, — we wish here distinctly to state our belief that all questions of curriculum are comparatively insignificant. The schools have a right to demand teachers that are prepared to teach history and have the ability and the spirit to teach it right. Public schools, supported by taxation, that are content with the old idea that anybody can teach history, that anybody can trace the line of life through the past and give his pupils the spark of interest and the fire of useful knowledge, have, in our opinion, a distorted conception of their responsibility. The great demand of the day is for teachers that have themselves inhaled the breath of enthusiasm, and that have knowledge, skill and force.

Seeley on the Complexity of History

Contrasting the history course in its methods and complexity with the science courses, Professor Seeley has made the following statement:[1]

In short, science brings together phenomena of the same kind, but history brings together phenomena of different kinds, which have chanced to appear at the same time. We have given to history the conscientiousness of science, but we have not yet given it the arrangement of science. We still arrange historic phenomena under periods, centuries, reigns, dynasties, but what is wanted is a real rather than a temporal classification. The phenomena should be classed under such headings as Constitutional, International, Economical, Industrial, etc. Nor should

[1] Methods of Teaching History, Pedagogical Library, Vol. I, pp. 198–199. D. C. Heath & Co., 1886.

each state be studied by itself, but all states together, the comparative method being constantly employed, and much attention being given to the classification of states.

It will be seen that this principle would be almost revolutionary if it were at once, and without reserve, applied to the teaching of history. I am sensible that it needs to be explained at great length, and I am quite aware how many objections might be urged against it. But I have not time either for fuller exposition or for dealing with objections, and therefore in the remainder of this paper I shall deal with an intermediate system which might, without too great difficulty, be adopted at once. The essential point is this, that we should recognize that to study history is to study not merely a narrative, but at the same time certain theoretical subjects. Thus, industrial facts cannot be understood without political economy, nor military facts without military science, nor legal facts without legal science, nor constitutional and legislative developments without political science. I have gone further, and laid it down that these theoretical subjects are the real object for which historical facts are collected and authenticated. But for the present it is enough that they should be recognized as inseparably connected with historical study. It has always been tacitly assumed that the historian is also an economist, an authority on constitutional law, on legislation, on finance, on strategy. Let us, then, go a single step further, and recognize that, as the historian is all this, the student of history must prepare himself to be all this — in other words, must master all these subjects. These are the great subjects of public life; these are the studies which make the citizen and train the statesman. All the poetic charm which history is losing would be amply compensated if it should acquire in exchange the practical interest that is associated with these studies.

Nationalism as an End of History Teaching

Furthermore, it is possible to show that history teachers are not entirely clear as to the functions of their subject by reviewing a discussion which has, of late, attracted a good

deal of attention. The earlier teachers of history never questioned at all the statement that the course in history was intended to develop a spirit of intense nationalism. The courses in European schools have long served explicitly this purpose of training the youths of each country in intense devotion to the interests of that country. When history began to find its place in the American course of study, it was natural that it should be assumed that one of the main purposes of the course is to cultivate a national spirit. History was thus made to serve a very genuine social end in the course of study.

Of late, however, the students of history have been calling attention to the fact that it is extremely difficult to pass judgments upon the acts of nations and individuals on the basis of the relatively meager knowledge which any student of history, especially an elementary student, can acquire. This whole discussion is made very clear in two quotations which may here be inserted.

> The study of United States history should infuse into the minds of American youths the American spirit, a benevolent disposition toward all classes of American citizens, a profound regard for all sections of the country, an admiration for free institutions, a willing obedience to the constitution and laws, and a deep and abiding love for the Union.[1]

On the other hand, the Committee of Seven[2] takes a position exactly opposed to that taken by Allen. This committee expresses itself very pointedly on the matter.

> The corresponding noteworthy fact is that, if a definite reason for the study of history is presented, it is the factitious one of patriotism. The idea that the chief object in teaching history is to teach patriotism is so thoroughly ingrained, not

[1] John G. Allen, Topical Studies in American History, p. v. Scrantom, Wetmore & Company.

[2] Report of the Committee of Seven on History Teaching, p. 160. The Macmillan Company, 1899.

only in America but in other countries, that it is extremely difficult to combat it. Yet it must be evident that the patriotism thus advocated is more or less a spurious one, a patriotism that would seek to present distorted ideas of the past with the idea of glorifying one country at the possible expense of truth. If the facts of the Franco-Prussian War should be used both in France and in Germany to inculcate this kind of patriotism, diametrically opposite results would be reached; if the American Revolution is to teach this patriotism both in England and in America, one nation or the other must be illogical; if the Northern and the Southern states of America should use the facts of the Civil War to promote either a national or a sectional patriotism of this character, those facts would have to be perverted. That the ultimate object of history, as of all sciences, is the search for truth, and that that search entails the responsibility of abiding by the results when found, is yet to be learned by many of our teachers of history.

The present condition of instruction in history in the schools is open to criticism for another reason. The curriculum has in many cases not been the result of educational experience or a product of educational theory. This fact explains in large measure the prevailing desire to use history as a vehicle for teaching patriotism. It probably does not admit of question that the curriculum of the public schools must and should be enacted by the state legislatures, but it is equally true that behind these legislatures should be organized bodies of competent advisers to whose decisions on educational matters the state legislatures should give the weight of their authority rather than themselves assume the initiative.

Intricacy of Moral Judgments

If we attempt to reduce this discussion to its psychological terms, we may make some such statement as the following: No person is in a position to pass judgment upon the moral character of any act unless he understands thoroughly all of the conditions which surround the act. In order to understand historical relations fully one needs

to have such a view of the historical situation as it is extremely difficult for a modern student to acquire. The modern student is, in the first place, guided in all of his judgments by an established mode of thought which is peculiar to his own generation. We have certain notions in this day about the treatment of colonies, for example, that are wholly different from the notions that obtained at the time that England was in controversy with her American colonies. The notions that we now entertain are the results of long historical periods which have recorded themselves in the literature and language of our people. The youth of to-day is introduced directly to these political and ethical ideas without any special reference to the earlier controversies out of which the present notions have grown. When, therefore, he is suddenly carried back in his historical studies to situations that differ altogether from the situations that now confront him, he is likely to carry back, without being fully aware of the fallacy of his procedure, those standards of judgment and canons of ethical thought which constitute his present inheritance. He judges, in other words, by modern standards, situations which are in character wholly different from those of to-day.

Memory and Historical Materials Defective

There is another way of expressing the same matter. We may say that any individual is always hazy in his efforts to recall past situations. His memory images are only partial. What is true of the individual is true also of the race. Its memories of its earlier struggles are incomplete. The difficulty of recording, as well as the difficulty of recognizing, the full details of any situation will always hamper the historian. The result is that the memory of the race is more defective than the memory of an individual who tries to recall his own past experiences.

This defective material is, however, regarded by the student as an adequate basis for a final judgment as to relative merits. He will more commonly err in his judgments than be right if he takes the position that his history is complete and his knowledge adequate. The historians, therefore, are striving, so far as they can, to impress upon teachers and students the necessity of being very cautious in condemning or eulogizing those who are described in history. One should be slow to pass moral judgments upon any historical character. At the same time, there can be no doubt that historical material stimulates any student to just this sort of consideration of the ethical values of all sorts of human relations. It is almost impossible to conduct a high-school course in American history which does not present to the student again and again the opportunities for forming his own judgments about the propriety of certain historical acts. It is inherent in history, as a subject, that it stimulates all sorts of human judgments. The student's imagination is kindled by the accounts given of human activities, and his sympathies are aroused in spite of every effort that he may make to keep his mind open for an impartial judgment. The effort of the historian, therefore, to describe history as a scientific subject is likely to fail to persuade an elementary student whose human sympathies are aroused by the narrative which he reads.

Chronological Judgment must be trained

There is one type of special judgment which may be regarded as peculiar to history. The student must learn, through his historical studies, to have a proper judgment with regard to time and the sequence of events in time. The Committee of Five has called attention in an interesting way to the importance of training students in this matter of time judgments. This report recommends that the

division between ancient and medieval history be set at the year 800 rather than at the year 476. The reason for this recommendation, as given in the report, is that if the earlier date is chosen the student is likely to think of ancient civilization as wholly set off from modern civilization. In this case the student loses the continuity of civilization and has a distorted chronological idea.

This single example can be elaborated by other examples from the experience of students. We may properly refer to the fact that little children in the elementary schools have no more notion of periods of time than they have of great spatial areas. The little child beginning his study of geography is seriously handicapped by the fact that he has never seen any large land areas. The space world, as he learns about it, is symbolical and abstract. In the same way the child has difficulty with time. Indeed, his difficulty with time is even greater than his difficulty with space. Little children very seldom know the difference between yesterday and the day before. Their memories are confused with regard to the dating of past experiences. As they grow older and have behind them a whole series of years of experience, they gain somewhat in ability to think of time and to mark off the different epochs of their own personal experience; but the long ranges of time continue to be extremely difficult for them to imagine and to fill up with historical events. The meager outlines of history which are given to them pass over centuries with a few isolated statements which make it quite impossible for the child to comprehend anything about the actual time units with which history deals. If his historical material is arranged in such a way that one body of descriptions stops at a certain definite date and a later body of information begins at a later date, there will be, exactly as the Committee of Five has pointed out, a break in his thought about historical sequences. His whole study of time is abstract. When dates are given to

him in such a way as to mark breaches between different types of civilization, the dates will be very impressive in controlling his abstract thought about civilization.

Devices for Training of Chronological Judgment

Various devices have at different times been used in school work to overcome this difficulty of establishing adequate chronological notions in history. In the older courses a pictured stream of events was often hung on the wall so as to keep constantly before the child's mind the continuity and breadth of the centuries through which he was supposed to pass in his historical studies. The complexity of such a graphic chart becomes so great if one studies in detail any historical period that the charts which were familiar on the walls of school buildings a generation or two ago have gradually been eliminated because the amount of material which the student is supposed to compass has increased to such an extent that these charts are no longer acceptable.

Sometimes teachers attempt to substitute a series of definite points in history for the picture of the whole sequence of events. The student is required to learn a set of important dates. Here again the difficulty is to limit the emphasis which shall be given to particular dates, and there is grave danger that the student's experience will be more broken up and subdivided by these dates than developed into a single continuity.

The abandonment of the chart device and the difficulty of getting a useful series of dates should not lead teachers to neglect the task of cultivating in students a system of chronological judgments. Students must be taught the meaning of a century and of a decade. They must learn to arrange events in sequence and in parallel. It requires constant attention on the part of the teacher to render these judgments clear and adequate, but the task is one of the essential aspects of history teaching.

Causal Judgment

A second type of judgment which is frequently emphasized in historical study is the causal judgment which the student is supposed to cultivate in the presence of historical facts. The Committee of Five has commented on this matter as follows:

> History cultivates the judgment by leading the pupil to see the relation between cause and effect, as cause and effect appear in human affairs. We do not mean by this that his attention should be directed solely to great moving causes, or that he should study what is sometimes called the "philosophy of history" — far from it; nor do we mean that time should be consumed in discussing the meaning of facts when the facts themselves are not known. But history has to do with the becoming of past events, — not simply with what was, but with what came to be, — and in studying the simplest forms of historical narrative even the average pupil comes to see that one thing leads to another; he begins quite unconsciously to see that events do not simply succeed each other in time, but that one grows out of another, or rather out of a combination of many others. Thus, before the end of the secondary course, the well-trained pupil has acquired some power in seeing relationships and detecting analogies. While it is perfectly true that the generalizing faculty is developed late, and that the secondary pupil will often learn unrelated data with ease, if not with avidity, it is equally true that history in the hands of the competent teacher is a great instrument for developing in the pupil capacity for seeing underlying reasons and for comprehending motives. (P. 21.)

Formal Statement of Results *versus* Judgment

The danger which arises in attempting to train students of history to acquire causal judgments is similar to that which was discussed in an earlier chapter in commenting on the serious difficulty of getting students to do scientific

thinking for themselves. Most of the causes and effects which students of history really canvass in their school work are given to them as the result of someone else's thought rather than as a result of their own reaction upon the situations which they study. They learn a list of causes and a list of effects, substituting this purely formal list for any genuine, personal thought about the situations under examination. It is not necessary here to recanvass the comments which were made in the chapter on the teaching of science; it is enough to point out that the causal relations in history are by no means as obvious as the causal relations in science. History is in this respect, therefore, a much more complicated subject than science as an instrument for teaching children to pass causal judgments. Causes in human society and in human behavior are frequently so obscure that they become matters of speculation if they are commented upon at all. This does not prove by any means that causal discussions should be eliminated from the history course, but it does make it perfectly clear that the teacher who lays great stress upon causal relations is dealing with a more complex type of material in history than in any other subject of the curriculum.

The Critical Examination of Historical Evidence

Finally, as has been frequently pointed out, history is designed to create in the mind of the student a critical attitude toward the evidences which are presented to him in historical narratives. This statement may be subdivided into two special statements of the way in which this training may be given. In the first place, historical evidence is very largely a matter of documents. The student must therefore become familiar with the use of books. Indeed, it may be pointed out, without fear of dispute, that the history course, if properly conducted, is more likely than

any other course in the school to familiarize the student with methods of using the library for reference. He must come in contact with the sources of his material. Critical judgment will naturally develop during the student's effort to secure his material.

There is a higher form of critical judgment which comes not through the mere collection of material but through the comparison of different authorities with each other. This higher form of critical judgment has sometimes been essayed in the secondary schools. It has been assumed that students can be brought in contact with old newspapers and with the reminiscences of some of the older members of the community, and that they will be able, through a comparison of the information collected from these different sources, to develop the true narrative of historical events. In the main it has been found that elementary students are not competent to carry on any large amount of work with original sources. It appears, on the other hand, to be very stimulating for any student to be brought into contact with some of the original sources. Undoubtedly extracts from contemporary writings constitute a very legitimate part of the collateral reading for any historical course; but the assumption that this can be made the sole or leading method of instruction in secondary schools has proved itself to be in opposition to the experiences of those who have attempted to use the source method in secondary-school instruction. The psychological reason for the inability of secondary-school students to study merely sources is not far to seek. The weighing of evidence requires a detached, impersonal attitude which is not easy for a student to assume. Furthermore, the complexity of such problems of the comparison of evidence takes the student's attention away from the central historical sequence which he is supposed to be following, with the result that he gets no adequate historical narrative. In general the sifting of

evidence is the business of the specialist. The elementary student gets his best view of the course of events if he is saved the complexities of research.

Training Imagination

One of the strictly psychological topics which has frequently been made the subject of comment in the reports of committees on history courses is the subject of imagination and the part which it plays in historical courses. The report of the Committee of Seven was criticized in some quarters because it assumed on the part of high-school students a power of abstraction which the experience of teachers did not justify. The Committee of Five, in canvassing this question, evidently sees the wisdom of emphasizing in the high-school course the cultivation of a great deal of concrete imagery on the part of students. Their comment on this matter is as follows:

> The secondary pupil must deal with real facts and with real men, with institutions as men worked in them and with them; he must have time to think and read as well as to learn. We must not forget that history merits a place in the curriculum because of its distinctly educational value; by it the pupil learns how the toil and labor of the past generations made the present; he learns to read and think of social problems. Such ends are not attained by any unreal and impersonal treatment of institutions and processes, or by the memorizing of chronological outlines. (P. 22.)
>
> Ancient history must be made simpler and less abstract; more attention must be paid to great men, less to the history of institutions; more time must be given to simple studies of art and habits of life; wars that mean nothing must be omitted, and time must be gained for easy, familiar talks and lessons about things that pupils of fourteen can understand. Constitutional details must give place to pictures and to stories of the great deeds and achievements of antiquity. An attempt to show just how this can be done would be out of place here.

There is an undoubted demand for textbooks that will aid the teachers in this difficult task; and there is need of abundant and cheap illustrative material. But the task must rest with the teacher. Difficult as it is, there is reason for thinking that it will be mastered. We feel confidence in saying that there is no other field of history so rich in materials of human interest and which can be made more vivid and comprehensible; but pupils will probably not be fired to enthusiasm by the reforms of Clisthenes, the duties of archons, the campaigns of the Samnite war, or the technicalities of the Roman constitution. (P. 36.)

There can be no doubt at all that the reconstruction of historical scenes is one of the best devices for elementary instruction in history. It must, indeed, be kept in mind that the historical course cannot deal exclusively with the mere description of events; but there is so much that is involved in the true representation of past situations that the student is likely by this method to get a training in historical criticism and historical judgment which he cannot get if he is not required to be exact and accurate in his descriptions.

Devices for stimulating and directing Imagination

A method which has of late come into vogue for historical study is the dramatic method of presenting historical events. The historical drama, like all imaginary pictures which the student must develop, calls for the careful scrutiny of much material. Students learn a great deal about Roman history from an effort to dramatize Julius Cæsar. Their attention is called to details of costume and details of social life which they would pass over if these were presented merely in verbal form without any clear appreciation of their meaning or exact character. On the other hand, there can be no doubt that the vividness of the dramatic presentation is so great that there is danger of substituting the scene, as partially worked out in the drama, for the

more complete personal idea which the student would have to cultivate if the drama had not been worked out for him.

The difficulty which is here pointed out is akin to that which was pointed out in discussing solid geometry, where attention was called to the fact that many teachers in solid geometry prefer to get on without a model of the figure which the students are studying. The reason there presented was that students fail to cultivate their imaginations just in the degree in which they are relieved from exercising their imaginations through the presence of real objects.

So here, if the historical drama is too vivid the student may substitute that which he sees for that which he ought to work out in his own thought. This difficulty is in some measure corrected by the historical pageant, which in many cases is a substitute for the drama. The historical pageant merely reviews the figures involved in historical scenes, giving some of the details of their appearance, but does not attempt to work out in detail all of their activities. There is, therefore, a stronger appeal to the imagination of the student in the pageant than in the drama.

Industrial History as a Substitute for Political History

One direction in which recent history studies have aimed to cultivate the thought and imagination of students more completely than was formerly the practice is in the direction of a full knowledge of the historical life of the common people. History has been remote from the experience of the ordinary student because the characters dealt with have been exclusively the leaders in the political and military world. If history is to be utilized by the ordinary student in cultivating any appreciative knowledge of earlier periods, he must have, as a part of his subject of thought, the life of people who, like himself, move in the common planes.

History of the purely military or political type has proved to be so barren for the student that there was a great recoil from the formalism of this type of content. This recoil from purely political history shows again how the historical course aims to cultivate the personal sympathies and personal judgments of all the students. There can be no doubt that history makes a large advance just in the degree in which it arouses in the student those more intimate forms of sympathy and judgment which are needed to put the individual in contact with the full life of earlier generations.

Application of History to Present Conditions

Writers on history frequently call attention to the fact that students ought to be able to apply the history which they read to the present. This application must often take the form of contrast. The student is made vividly aware of present modes of institutional life by having his attention drawn to the fact that other nations and other ages have dealt with situations in a way wholly different from that which he observes in present institutions. On the other hand, the application of history to present institutions may take a more direct form if the student is made acquainted with the reason for the present mode of organization. Take such an institution as the United States Congress with its two Houses. What is the historical origin of this body? We have here an interesting constitutional question which can be discussed from the point of view of its history in such a way as to make the student clearly aware of the reason for the dual organization of this legislative body.

A very productive suggestion has recently been made in the method of historical presentation, in that some event of crucial significance in the life of the nation has been made the starting point for a backward inquiry as to the causes that led up to this particular event. If one could determine

step by step the different conditions that had made inevitable the present situation, he would have an historical study which, in its applications, would be perfectly obvious since the historical study would be undertaken for the purpose of giving an explanation of the present situation.

In general, history begins at the chronologically remote point, and the application to the present is reserved for a later period of the course. Application thus becomes an extremely difficult part of the work. It would be interesting for some vigorous secondary-school teacher to try the experiment which, as indicated in the foregoing paragraph, has been tried in more advanced courses offered to research students.

History a Center of Correlations

History, more than any other subject in the curriculum, has been studied with regard to its correlation to other subjects. The Herbartians called attention to the importance of history as a central subject in the curriculum. In view of the fact that the training of the younger members of the race is the natural outgrowth of the historical development of the race, it seems very natural to point out that historical studies can be utilized as the best instruments for introducing children to the institutions in which they must live. The Herbartians, therefore, would make the historical narrative the basis for the development of all of the other forms of school work. They would allow science to attach itself to the historical narrative and to receive that emphasis which can be justified by reference to the relations between science and industry. Especially would they show the relation between geography and history, calling attention to the fact that the movements of races and their economic undertakings all depend on the physical environment in which they grow up.

All of these correlations between history and the other subjects emphasize the fact, which has been pointed out again and again in this discussion, that history is a very broad subject in its content and in the judgments which it aims to cultivate in students. There is one practical suggestion which tends to utilize the possibility of correlating history with other subjects and serves at the same time to supply a way out of a difficulty mentioned in an earlier discussion. It has been recommended that a good deal of the English work which is now apparently without motive and lacking in proper content could be made more productive if the time that is consumed in aimless writing and reading trivial material could be related in some way to the requirements of the history course. At all events, there can be no doubt at all that a broad subject like history invites a broader type of training than most of the special subjects in the curriculum. The teacher of history should be sufficiently interested in these relations to work out material which will satisfy the legitimate demand for correlation of his subject with the other courses.

Finally, in this connection it is interesting to note that the demand is being felt more than ever for a study of the history of industry. This demand grows out of the development of technical courses in secondary schools, which technical courses are demanding the same kind of academic background as that which has heretofore been provided for the other subjects of the curriculum.

The remaining topics which might be taken up in discussing history as a special subject are topics which have already been touched upon in discussing other subjects in the curriculum, and we may with propriety turn over to a series of general chapters such problems as discipline, methods of study, and the organization of the students' curriculum.

CHAPTER XVII

GENERALIZED EXPERIENCE

Attacks on the Doctrine of Formal Discipline

Discussions of formal discipline have been carried on with vigor and keen partisan feeling during the last two decades. The report of the Committee of Ten [1] stimulated Professor Hinsdale [2] and others to open the discussion in terms of Herbartian psychology and pedagogy. Following this report of the Committee of Ten came a series of statistical investigations and experiments by students of educational psychology. Those who are not interested especially in the scientific study of education have been drawn into the controversy. The discussion was taken up by the opponents of the classics who found that the arguments in favor of the teaching of the classics in the schools were couched in a terminology which made the classicists appear as the natural defenders of the doctrine of discipline. Attacks on the doctrine were especially welcome to representatives of the new subjects which base their claims for their reception into the course of study upon the rich variety of content which they offer to the student. The sciences, for example, have been assumed to contain so much valuable information capable of practical application to the activities of ordinary life that the advocates of these subjects have been very glad to see the classics under fire because of their

[1] Report of the Committee of Ten. Published separately by the American Book Company, 1894.

[2] Address by B. A. Hinsdale, "The Dogma of Formal Discipline," *Proceedings of the National Education Association*, 1894, p. 625.

alleged inability to furnish training that can be recognized as of immediate practical value.

It will be noted from the foregoing remarks that the discussion has been from the outset of a partisan type, and to-day it bears all of the marks of an intense partisan controversy. There is very little sobriety of statement on either side. The classicists, still feeling that they must defend their subjects as giving a type of mental training which will be valuable to the student, and finding that the very terms which they employ are under criticism by students of educational psychology, are bitter in their counter attacks upon everybody, including students of the science of education. In some cases they have felt it necessary to go so far as to assert that there is nothing at all in the science of education. On the other hand, the opponents of the classics have made the most extreme statements, holding that the argument that a subject disciplines the mind is an absolutely unacceptable ground for the admission or continuance of any subject in the school curriculum.

Extreme Critics ask for Reformulation

There are some evidences that this partisan discussion has reached its climax and that we are now in a position to take up the serious scientific discussion of the doctrine of formal discipline and its meaning. For example, Thorndike, who has long posed as one of the strongest opponents of the doctrine of formal discipline, writes in the second volume of his "Educational Psychology" [1] as follows:

> These experimental facts as a whole, like those concerning memorizing, leave a rather confused impression on one's mind, and resist organization into any simple statement of how far the improvement wrought by special practice spreads beyond the function primarily exercised. They do, however, at least

[1] E. L. Thorndike, Educational Psychology; Vol. II, The Psychology of Learning, pp. 417, 418. Teachers College, 1913.

put out of court the old doctrine of a very wide spread of a very large percentage of the special improvement. Possibly nobody really believed that the improvement made in reasoning about Latin syntax would spread equally, or almost equally, to all or nearly all varieties of reasoning; but men wrote as if they believed substantially this. Certainly nobody can now believe it in the face of these experiments.

It is indeed doubtful whether anyone ever held the extreme views sometimes described by the opponents of the doctrine of formal discipline. This fundamental ambiguity is amusingly illustrated in such cases as the following. We find O'Shea[1] complaining bitterly because he cannot find anyone who will state the doctrine of formal discipline in such a way that he can attack it to his heart's content. He says:

Those who profess to believe in the virtues of formal mental discipline are still not willing to carry it to its logical conclusions. They will not say that any particular sort of mental activity will benefit the mind on every side. They maintain rather that the training of perception in any direction improves the power of perception in every direction, but not the power of reason, or memory, or imagination. Here the theory that all possible mental functions are benefited in the same degree by any variety of experience is abandoned, and it is implied that there are various departments, as it were, to the mind, from each of which may be produced special articles of mental merchandise according to the needs of the moment. We cannot draft the power developed by exercising the perceiving faculty, for instance, into the service of the remembering faculty; nor can power of memory be utilized in carrying forward reason or imagination.

The same sort of complaint is made by Heck:[2]

Finally, we notice that adherents of the doctrine of formal discipline shrink from carrying their doctrine to its logical

[1] M. J. O'Shea, Education as Adjustment, p. 251. Longmans, Green, & Co., 1903.

[2] W. H. Heck, Mental Discipline and Educational Values, pp. 125 ff. John Lane Company, 1911.

conclusions, namely, the exact equivalents of studies for mental discipline or, if a distinction is made between them, the concentration on a single superior study for the training of a given power or set of powers. In practice, if not in theory, these adherents acknowledge a variation in training of a given power or set of powers as related to a variation in content of study. A case in point is the inconsistency of the Committee of Ten on Secondary School Studies in stating what seems to be a belief in the equivalence of studies and then specifying elaborately varied curricula, representing different phases of the environment, different subject-matter and method.

Case against Formal Discipline exaggerated

One might go on multiplying examples from the writings of the opponents of the doctrine of formal discipline to show that they have never really succeeded in finding the extreme position which they like to attack actually represented by any one of the advocates of the doctrine. It is interesting to note that the quotations which are given by Thorndike and others in support of their contention that the doctrine of formal discipline has been whole-heartedly advocated by teachers of the classics and their friends are very labored. For example, if one takes the first quotation used by Thorndike in the successive reprints[1] of his attack upon the doctrine of formal discipline, he finds the following, on the whole, fairly innocuous statement:

> Since the mind is a unit and the faculties are simply phases or manifestations of its activity, whatever strengthens one faculty indirectly strengthens all the others. The *verbal* memory seems to be an exception to this statement, however, for it may be abnormally cultivated without involving to any profitable extent the other faculties. But only things that are rightly perceived and rightly understood can be *rightly* remembered. Hence whatever develops the acquisitive and assimilative

[1] For example, Educational Psychology, Vol. II, p. 360.

powers will also strengthen memory; and, conversely, rightly strengthening the memory necessitates the developing of other powers. (R. N. Roark, "Method in Education," p. 27.)

Extreme Critics appear at Times as Ardent Advocates

It will be noted that this quotation, presented by Thorndike as the first example of the teachings of the advocates of formal discipline which he feels compelled to refute, differs very little from statements which might be extracted from Thorndike's own writings. For example, on a later page of the same volume[1] he reprints with evident satisfaction an extract from one of his own earlier works as follows:

Identity of Procedure. — The habit acquired in a laboratory course of looking to see how chemicals do behave, instead of guessing at the matter or learning statements about it out of a book, may make a girl's methods of cooking or a boy's methods of manufacturing more scientific because the attitude of distrust of opinion and search for facts may so possess one as to be carried over from the narrower to the wider field. Difficulties in studies may prepare students for the difficulties of the world as a whole by cultivating the attitudes of neglect of discomfort, ideals of accomplishing what one sets out to do, and the feeling of dissatisfaction with failure.

It will be remembered that identity of procedure and practice is what Roark is advocating in the earlier paragraph. Furthermore, one may turn to those who have been influenced by Thorndike's writings for examples which illustrate admirably the difficulty of distinguishing between those who are in favor of formal discipline and those who are not. In his interesting book, "The Teaching of Physics," Professor Mann[2] is very clear in the earlier chapters that the

[1] Educational Psychology, p. 431.

[2] C. R. Mann, The Teaching of Physics. The Macmillan Company, 1912.

doctrine of formal discipline should be violently attacked. He says on page 183:

> The first point to be noted is that training in any subject is specific, not general. . . . Thinking, like training, is always specific, that is, connected with some practical situation and dependent upon the specific nature of the situation as a whole.

One hardly settles his mind to the acceptance of this doctrine of specific discipline when he comes, on page 214, to the following wholesale adoption of the doctrine of formal discipline:

> Discipline in the methods of acquiring this useful knowledge results not only in skill in weighing evidence and in criticising and testing data, in openmindedness or the ability of holding conclusions tentatively and of altering them whenever new evidence demands it, and in the ability of predicting consequences and of making judgments that shall have the greatest possible degree of validity; but also in self-forgetfulness, perseverance, self-respect, and resourcefulness in the face of difficulties.

Criticisms of the Report of the Committee of Ten

Perhaps the above quotations will be enough to convince the impartial reader why it is very difficult to find anyone sufficiently clear on the doctrine of formal discipline to be accepted as a suitable target for those who suppose themselves to be in opposition to this doctrine. One other example, however, of the partisan spirit of this discussion may be cited in view of the reference made by Hinsdale,[1] Heck,[1] and others to the report of the Committee of Ten. This report has been referred to in many quarters as advocating the doctrine of formal discipline. If we turn to the minority report of the Committee presented by Baker we find the

[1] Report of the Committee of Ten, Edition of 1894, pp. 56, 57. American Book Company.

following statements which indicate that Baker himself evidently thought that the rest of the Committee were in favor of formal discipline:

I cannot endorse expressions that appear to sanction the idea that the choice of subjects in secondary schools may be a matter of comparative indifference. I note especially the following sentences, referring the reader to their context for accurate interpretation.

"Any school principal may say:—'With the staff at my command I can teach only five subjects out of those proposed by Conferences in the manner proposed. My school shall, therefore, be limited to these five.' Another school may be able to teach in the thorough manner proposed five subjects, but some or all of these five may be different from those selected by the first school.

"If twice as much time is given in a school to Latin as is given to mathematics, the attainments of the pupils in Latin ought to be twice as great as they are in mathematics, provided that equally good work is done in the two subjects; and Latin will have twice the educational value of mathematics.

"The schedule of studies contained in Table III permits flexibility and variety in three respects. First, it is not necessary that any school should teach all the subjects which it contains, or any particular set of subjects.

"Every youth who entered college would have spent four years in studying a few subjects thoroughly; and on the theory that all the subjects are to be considered equivalent in educational rank for the purpose of admission to college, it would make no difference which subjects he had chosen from the programme — he would have had four years of strong and effective mental training."

All such statements are based upon the theory that, for the purposes of general education, one study is as good as another, — a theory which appears to me to ignore Philosophy, Psychology and Science of Education. It is a theory which makes education formal and does not consider the nature and value of the content. Power comes through knowledge; we cannot conceive of observation and memory in the abstract.

Criticism based on Obvious Misinterpretation

Inasmuch as the Committee's report itself contains a minority statement which thus charges the Committee with adherence to the doctrine of formal discipline, and inasmuch as this tradition about the Committee of Ten has been perpetuated in some of the later discussions of the subject, it may be well to call attention to the fact that the last paragraph in Baker's quotation, which is also quoted by Hinsdale and others, was written not as a part of a discussion of the general educational value of high-school subjects but rather as part of a statement dealing with the organizing of a college preparatory course. What the Committee asserted was that the high school of to-day cannot formulate its course of study with a view merely to preparing for college. The school must organize its courses in such a way as to offer to all of the young people in the community as large a range of subjects as possible with a view to preparing them for the ordinary duties of citizenship. This is the principle which the Committee lays at the foundation of its various programs of study. Having organized the course of study for the high school in this general way, it finds that the problem of preparing for college must be treated as a secondary problem. The Committee holds that the preparation for college, being a relatively incidental matter, will be adequately taken care of within the limits of the courses which it has arranged if all the subjects which are taught are raised to a uniform level of excellence. All of the different courses being regarded by the Committee as of value for the training of a student, the student who is to go to college may extract from the total series of possibilities those particular courses which he wishes to elect. The college may safely rely upon the outcome of this secondary training because it has been completely and thoroughly organized in the general programs

laid down by the Committee. It is at this point that the statement quoted from the Committee's report appears. How anyone could read this report and find justifications for Baker's minority report, or for the statement made by Heck and quoted on page 394, is difficult for an unbiased student of education to determine. Certainly there must be in any social or educational situation which permits this partisan misinterpretation much greater intensity of partisan feeling than sobriety of intellectual evaluation of positions.

Hadley on Greek and Formal Discipline

One further quotation may be added to show that the statements of those who are in favor of the general doctrine of formal discipline are by no means so extreme on the one hand as has been assumed by the opponents of this doctrine, nor on the other hand greatly at variance with Thorndike and others who are in favor of the doctrine of identity of procedure. The following quotation from the presidential report of President Hadley in 1909 is an admirable statement of the doctrine.[1]

One of the chief causes which have given the teaching of Greek its importance in American colleges was well stated in President Garfield's inaugural.

"That some subjects produce better results than others in the same general group is due rather to the accident of time and to perfection of method, than to qualities inherent in the subjects. Consider, for example, the teaching of Greek. Both the language and the method of instruction have been standardized, if I may borrow a term from the shops. This result has come about, in part, because the language is 'dead,' thereby lending itself to fixed methods of analysis and treatment, and in part because it has been studied long enough, since its

[1] Report of the president of Yale University, 1908–1909, pp. 7–9, 22. Published by the University, 1909.

revival, to enable teachers to agree upon the authors to be read and the order in which their work can most profitably be placed before the student.

"These considerations give to Greek, as to Latin, a peculiar claim to consideration as a discipline, wholly aside from the question of literary quality and historic value."

What does this last sentence mean? It means, I think, that if a man has passed an examination in Greek, you know that he has studied Greek to some purpose, and is likely to work to the same purpose in other things that he may take up. Greek is an intellectual game where the umpires know the rules better than they know the rules in the game of French, for instance, or history, or botany. A man's rating in an examination on any one of these last three subjects is largely the result of accident unless the examiner is quite unusually skillful. A man's rating in Greek, on the other hand, means something. There never were intellectual competitions keener than the classical competitions at Oxford in the days when the best men in England wanted their sons to learn that particular game.

Unfortunately, a large number of the strongest men, both in England and in the United States, have decided that this game takes more time than it is worth. Personally, I believe that this change of mind is in many respects a misfortune; that in trying to get more practical results in the way of knowledge or culture a great many American college boys have lost the training which the Greek would have given them and gained nothing of equal value in its place. But colleges cannot teach a thing to a public which does not want to study it; and we must recognize the fact that an increasing part of the American public does not care to have its sons give the time necessary for the effective use of the Greek language as a means of competition and discipline.

This makes academic problems more difficult. It is infinitely harder to manage a college where the students do not want to study Greek than one where they do. It is harder to enforce habits of regularity; harder to organize general intellectual competitions; harder to be sure that examination marks are a test of ability. But we must meet the facts as they are. We

cannot decline solving the problem of to-day because we like the problem of yesterday better.

It was a mistake for the advocates of the old curriculum to think that all the students required the same treatment. It is, I believe, an equal mistake for the advocates of the elective system to think that each student requires a different treatment. For while there is a very large number of subjects of interest to study, and an almost infinite variety of occupations which the students are going to follow afterwards, there is a comparatively small number of types of mind with which we have to deal. If we can have four or five honor courses, something like those of the English universities, where the studies are grouped and the examinations arranged to meet the needs of these different types, we can, I think, realize the chief advantages of the elective system or the group system without subjecting ourselves to their evils. I am confident that we can secure a degree of collective intellectual interest which is now absent from most of our colleges, and can establish competitions which will be recognized not only in college but in the world as places where the best men can show what is in them.

It may be objected that any such arrangement would render it difficult for a boy to study the particular things that he was going to use in after life. I regard this as its cardinal advantage. The ideal college education seems to me to be one where a student learns things that he is not going to use in after life, by methods that he is going to use. The former element gives the breadth, the latter element gives the training.

Distinction between Form and Content Difficult

A part of the misunderstanding regarding formal discipline grows out of the fact that the terms in which the discussion has been carried forward are themselves very unfortunate. In the first place, a distinction between formal subjects and content subjects is quite impossible to draw and has never been strictly adhered to in any of the discussions. One finds, for example, that Thorndike is constantly discussing identity of procedure and identity

of substance. His term "procedure" may be regarded as synonymous with the term "form," while his term "substance" is synonymous with the term "content." It is evident, therefore, that in his own mind the discussion is not limited to form on the one hand as distinguished from substance on the other, nor to content as distinguished from the modes of mental activity.

Reaction against Discipline

In the second place, the term "discipline" undoubtedly carries to the minds of many thinkers an implied criticism. The term "discipline" reminds one of the early days of educational theory when it was assumed that the child is by nature unregenerate and perverse. The child must in some fashion be changed so that he will become an individual of the accepted type in society. This earlier notion about child nature had its sources in the theological prejudices of the medieval period. It was assumed by the theologians who tried to frame their school work on the basis of a pietistic or puritanic religious theory that there is nothing in the world so bad as that which is natural. Today we are all of us prepared to assume exactly the opposite attitude. Studies of mental development and of social organization have convinced all of us that Nature is constantly working for the improvement of the species and the individual. Nature provides devices which constantly make for betterment. Consequently, if we can do anything which will aid Nature in the processes which she is carrying on, we shall have worked to the advantage of all concerned. This attitude with regard to Nature makes us skeptical about any form of training which seems to run counter to Nature. When one reads Herbert Spencer's unqualified statement that we may properly depend upon the child's own judgment of what is agreeable to him, since all education

which is natural is sure to arouse a pleasurable feeling; when one reads in the Herbartians that the child's interest is a suitable criterion for the selection of school material and modes of procedure; when one reads the pleas of the students of physical education for more of the play type of activity in school work, he realizes that the day of discipline as a favorite educational concept is past. No one can get a hearing to-day for any doctrine which repudiates Nature at the outset. Consequently, the use of the term "discipline" is unfortunate. No subject can afford at the present time to bear the burden of this doctrine of discipline. If the classicists want an impartial hearing of their case, they should abandon that word altogether. Whatever virtues there may be in learning how to overcome distractions; whatever advantages there may be to the student in learning to concentrate his attention; he must be freed, so far as popular thought is concerned, from the necessity of doing all this in a way that is opposed to Nature. We must treat concentration as a natural characteristic of the mind. If we have to cultivate it by strenuous endeavors we must not say that the mind has been disciplined into concentration; we must say rather that the mind ought to be allowed to express its own tendencies. We must learn to use phrases which will free us from controversies with medievalism.

No One denies the Fact of Transfer of Training

The discussion of formal discipline as it has been carried on by recent writers can legitimately be expressed in entirely neutral terms. It is in fact a discussion of the degree to which training gained in one sphere of thought and activity can be transferred to other spheres of thought and activity. Special emphasis may furthermore be laid on the fact that there is no one who denies that some kind of

transfer takes place. The real questions at issue are what is the degree of transfer and what is its method. It should perhaps be reiterated that it is entirely out of keeping with the evidence to assume that there is anyone who believes that the transfer is uniform and absolute. Sometimes the opponents of the doctrine of formal discipline write as though they thought that the advocates of this doctrine believe in absolutely equal transfer in all directions. Note Thorndike's comment quoted on page 393. Note also the statements that were made above from O'Shea and Heck, where it was pointed out that they cannot find anyone who goes the whole length of advocating complete transfer of powers.

The Real Problem that of Degree of Transfer

The fact is that in all of these cases the real question is one of degree. Thorndike's statement of the problem which he wishes to discuss is thus somewhat biased by his confusion of two distinct problems. He himself admits that there is some degree of transfer. He wishes to put his opponents in the position of stating that the transfer is more general than he admits, and that it takes place by a method other than that which he accepts. His preliminary definitions are quoted from his "Principles of Teaching." [1]

> The problem of how far the particular responses made day by day by pupils improve their mental powers in general is called the problem of the disciplinary value or disciplinary effect of studies, or more briefly, the problem of formal discipline. (P. 235.)
>
> A common answer of the theorists about human life and education has been that each special mental acquisition, each special form of training, improves directly and equally the general ability. Teachers have believed and acted on the theory

[1] E. L. Thorndike, The Principles of Teaching. A. G. Seiler, 1906.

that the mind was a collection of faculties or powers — observation, attention, memory, reasoning, will and the like — and that any gain in any faculty was a gain for the faculty as a whole. (P. 236.)

The powers of the mind are supposed to work irrespective of the data with which they work. Improvement in one special power rarely, if ever, means equal improvement in general. (P. 237.)

Critical Examination of Evidence by Critics

We shall first take up the problem of the degree of transfer. It would be simpler to marshal the abundant positive experimental evidence that transfer of a high degree is very common, but the rules of argumentation dictate that we use the material which has been the basis of the opposite conclusion. We turn, therefore, to Thorndike's text for his evidence that transfer of training is very slight. We quote in full his statement.[1]

The exact extent to which the improvement of any special capacity does improve other capacities than itself can be estimated from two lines of evidence, one concerning the extent to which special capacities are related one to another in the human mind and the other concerning the actual effect of special training on general ability as found by scientific investigations.

Common observation should teach that mental capacities are highly specialized. A man may be a tip-top musician but in other respects an imbecile: he may be a gifted poet, but an ignoramus in music: he may have a wonderful memory for figures and only a mediocre memory for localities, poetry or human faces: school children may reason admirably in science and be below the average in grammar: those very good in drawing may be very poor in dancing.

Careful measurements show that the specialization is even greater than ordinary observation leads one to suppose. For instance those individuals who are the highest ten out of a hundred in the power to judge differences in length accurately are

[1] The Principles of Teaching, pp. 238–240.

by no means the highest ten in the ability to judge differences in weights accurately. In fact they are not very much above the average. The best ten out of a hundred in observing misspellings in words are not very much better off than the worst ten when we test their ability to observe the shape of objects. Similarly, quickness and accuracy in thinking of the sums of numbers by no means implies equal quickness and accuracy in thinking of the opposites of words.

The records given below are samples of many that have been obtained by scientific students of education, all testifying to the complex specialization of human capacities, and the existence of variations in any power according to the data with which it works.

The ranks for thirty students throughout their college course were as follows:

Individual	Rank in English	Rank in Latin, French, and German	Individual	Rank in English	Rank in Latin, French, and German
A	1	2	P	16	16
B	2	13	Q	17	17
C	3	1	R	18	18
D	4	3	S	19	20
E	5	4	T	20	24
F	6	5	U	21	30
G	7	9	V	22	25
H	8	6	W	23	19
I	9	8	X	24	21
J	10	10	Y	25	22
K	11	11	Z	26	7
L	12	28	a	27	29
M	13	12	b	28	23
N	14	14	c	29	26
O	15	15	d	30	27

The ranks for thirty-five fourth-grade girls in two mental tests[1] are shown on the following page:

[1] The two tests were: (1) in quickness and accuracy in observing A's in a sheet of capital letters, words containing certain combinations of letters and the like, and (2) in quickness and accuracy in thinking of the opposites of words. They may be called tests of (1) observation and (2) of association.

Individual	Rank in observation	Rank in association	Individual	Rank in observation	Rank in association
A	1	5	S	19	7
B	2	16	T	20	35
C	3	1	U	21	13
D	4	2	V	22	3
E	5	29	W	23	33
F	6	26	X	24	25
G	7	10	Y	25	29
H	8	24	Z	26	12
I	9	27	a	27	15
J	10	14	b	28	23
K	11	20	c	29	8
L	12	9	d	30	22
M	13	4	e	31	31
N	14	19	f	32	6
O	15	30	g	33	18
P	16	32	h	34	21
Q	17	17	i	35	34
R	18	11			

The ranks for twenty-five high-school boys in discriminating lengths and in discriminating weights were as follows:

Individual	Rank in accuracy with lengths	Rank in accuracy with weights	Individual	Rank in accuracy with lengths	Rank in accuracy with weights
A	1	4	N	14	11
B	2	8	O	15	15
C	3	24	P	16	10
D	4	12	Q	17	25
E	5	5	R	18	13
F	6	17	S	19	3
G	7	2	T	20	19
H	8	14	U	21	21
I	9	6	V	22	22
J	10	7	W	23	1
K	11	20	X	24	16
L	12	23	Y	25	18
M	13	9			

Many facts such as these prove that the mind is by no means a collection of a few general faculties, observation, attention,

memory, reasoning and the like, but is the sum total of countless particular capacities, each of which is to some extent independent of the others, — each of which must to some extent be educated by itself. The task of teaching is not to develop a reasoning faculty, but many special powers of thought about different kinds of facts. It is not to alter our general power of attention, but to build up many particular powers of attending to different kinds of facts.

A Simpler Statement of the Tables

The student will understand these tables better if we recalculate them for him. In the first table individual A stands in the first position in English and in the second position in languages. He is displaced, therefore, by one position. Individual B in this table is displaced eleven positions. If in this fashion we go through the whole table and indicate the amount of displacement, we find that there are two groups of cases. There is one group in which the displacement is very slight. Thus, there are seven members of the group of thirty who are not displaced at all; that is, they assume exactly the same position in the English series as in the foreign-language series. Seven members of the group of thirty suffer only a single point of displacement. There are four cases where the displacement is two positions; five where the displacement is three; three more where the displacement is five or less. We now have four scattering cases in which the displacement is very large. One of these cases has a displacement of nine; one, eleven; one, sixteen; and one, nineteen.

Striking Positive and Negative Correlations

How an astute observer like Thorndike could fail to recognize that he has in these figures a very interesting indication of the fact which is known to every teacher is

difficult to understand. Teachers realize that there are some students who acquire in each study better equipment for general school work. There are other students who become so absorbed in a single line of training that they are actually interrupted in the rest of their school work. It is very easy to find in any school some member of the Latin class who has become so absorbed in this one subject that he neglects the rest of his work in order to be perfect in this subject. It would be natural to expect that such a student as this would suffer a very large displacement if his marks in Latin were compared with his marks in English.

Thorndike's table makes it perfectly clear that such facts lie before us in abundance in every class. Here are some students whose work correlates; others who show the sharpest contrasts. Why should anyone be satisfied to throw all these cases together, and shutting his eyes draw out an average? What does the average show? Nothing but this: in a large class there are enough different kinds of transfer so that if you mix them thoroughly you will find no transfer. Note that all you need to do if you want to cover up correlations is to continue to mix until the desired result is reached.

The Fallacy of using Tests without Critical Interpretation

A second fact which comes out in Thorndike's tables is that our methods of testing students are such that it is extremely difficult to know how much transfer we ought to expect between the different functions under discussion. In the second and third tables presented above, investigations are reported of the degrees of correlation between quickness and accuracy of observation and association, and between the abilities exhibited by high-school boys to discriminate lengths and weights. The table on discrimination

of lengths and weights, like the first table, shows a relatively very high degree of correlation. Students are displaced only in a few isolated instances more than seven or eight places. These few isolated instances, like the cases of negative correlation in the first table, are just as important to the educator and just as significant for educational theory as the cases of the students showing a high degree of positive correlation. Whenever two mental functions are opposed to each other the relationship between the two opposing functions is quite as important to the teacher as the relationship between two functions which coöperate with each other.

The second table, in which observation and association are contrasted with each other, shows a very wide disparity in the standings of individuals, but it does not follow from this disparity that it is the students who are responsible. Before an investigator begins to draw inferences from his tables he ought certainly to recognize the fact that a table depends for its significance on the kind of comparison which it institutes. Who could expect to compare the quickness and alertness in observation and association exhibited by fourth-grade girls with the same degree of finality as he could reach in comparing the attainments of college students in English and in foreign languages? It has long been recognized by all students of education that a single test is a very unreliable basis on which to make a generalization. It would be very much better to throw out this table on observation and association than to attempt to build upon so slender a foundation the structure of a general educational doctrine, especially when this table differs so radically from the other two on the same page.

This table also shows that the methods of investigation have much to do with the degree of transfer which is shown in any given situation. Furthermore, it is not merely the method of testing that influences the result; the method

of training is also of the greatest influence. Our school organization has undoubtedly been responsible for much of the separation between subjects under which students have suffered. In dealing with English, for example, we had frequent occasion to point out that the influence of English courses is not general because of the way in which these courses are organized. The same type of argument may be applied to other courses in the curriculum.

The negative evidence offered by the critics of formal discipline thus turns out to be of the thinnest possible type. They have not only not proved a negative; they have presented a series of facts which calls loudly for affirmative discussion.

What is the Method of Transfer?

We are thus brought to the second phase of our topic. It is, as we have seen, admitted on all sides that transfer of some degree takes place. The next question is, How does transfer take place, or, What conditions secure much transfer and what secure little?

Transfer depends on the Power of Generalization

The first and most striking fact which is to be drawn from school experience is that one and the same subject matter may be employed with one and the same student with wholly different effects, according to the mode of presentation. If the lesson is presented in one fashion it will produce a very large transfer; whereas if it is presented in an entirely different fashion it will be utterly barren of results for other phases of mental life. It is quite possible to take one of the objects of nature study, for example, and to teach it in such a way that it becomes an isolated

and utterly formal possession of the student. This has been illustrated time and time again by the instruction which has been given in birds and plants. A teacher can teach birds and plants in such a way as to arouse a minimum of ideas in the student's mind. The training may be as formal in these content subjects as it ever was in language instruction. On the other hand, the same subject matter may be taken by a different teacher, and under other methods can be made vital for the student's whole thinking. Thus the teacher who is dealing with birds as a subject of nature study and secures an interest on the part of his students for the world in which these birds live, through an examination of the structures and habits of the birds, will have in this subject matter one of the most broadly interesting topics that can be taught. In exactly the same way a teacher who knows how to make use of the materials given in a Latin course may render this subject very broadly productive, as contrasted with the teacher who merely gives the formal aspects of the subject. Formalism and lack of transfer turn out to be not characteristics of subjects of instruction, but rather products of the mode of instruction in these subjects.

James on Generalization

The important psychological fact involved in the above statements is that the extent to which a student generalizes his training is itself a measure of the degree to which he has secured from any course the highest form of training. One of the major characteristics of human intelligence is to be defined by calling attention, as was pointed out in the chapter on science, to the fact that a human being is able to generalize his experience. James has discussed this matter by using the example of the animal trained to open a particular latch. The animal becomes acquainted with

the necessary movements to open one door, but he never has the ability to generalize this experience. He cannot see that the same method of opening doors is applicable to many other latches. The result is that the animal goes through life with one particular narrow mode of behavior, and exhibits his lack of intelligence by his inability to carry this single type of skill over to the other cases which are very familiar to the trained human intelligence.

James goes on to say that the same distinction appears when we contrast a trained scientific mind with the ordinary mind. The ordinary thinker does not see how to deal with a situation in terms of scientific principles. James cites the example of his own experience with a smoking student-lamp. He discovered by accident that the lamp would not smoke if he put something under the chimney so as to increase the air current, but he did not realize that what he had done was only one particular example of the general principle that combustion is favored by a large supply of oxygen. The general principle and its useful application belong to a sphere of thinking and experience which the untrained layman has not yet mastered.[1]

The Theory of Identical Elements Loose and Ambiguous

When one studies the psychology of generalization he becomes aware of the uselessness of some of the formulas which have been proposed by those who hold that transfer of training takes place in cases where there are identical elements present. The identical element is usually contributed by the generalizing mind. On the other hand, there may be identical elements potentially present in various situations, but wholly unobserved by the untrained or lethargic mind. In fact, the discovery of the identical

[1] Principles of Psychology, Vol. II, p. 339.

element in a situation is in some cases the whole problem of training. Take the famous illustration of Newton's discovery. He saw for the first time that the relation between the moon and the earth is identical in character with the relation between the earth and everything which falls toward its center. The discovery of this identity in the two situations was the great achievement of a scientific mind. The discovery of identical elements in all of the Indo-European languages was the achievement of the students of comparative philology who a generation ago established the broad principles of the scientific study of grammar and word structure. The discovery of identical elements in two situations was in both cases an achievement of trained minds applying themselves to situations which heretofore had defied analysis. Or we might borrow our illustrations from the world of mechanics. The discovery of a common mechanical principle in all of the situations which involve the use of the wedge and the inclined plane is an achievement of mature physical science. Primitive man did not recognize in these different situations a common principle, nor was he able to carry over from one practical device to other practical situations the experiences that he had accumulated in the accidental use of one tool after another. We may express this limitation of primitive intelligence by saying that although common modes of procedure were possible in these different cases, they were not discovered.

Bagley on Transfer of Neatness

Let us see how the same general criticism applies to the discussion of another well-known case. The frequently quoted experiments which Bagley utilizes in his discussion of formal discipline[1] show that children who had been taught

[1] W. C. Bagley, The Educative Process, p. 208. The Macmillan Company, 1908.

in the schools to keep their papers neat in the arithmetic class did not adopt the same mode of procedure in other lines of work. It was of course possible for them to find in the other classes opportunities for neatness equal to those which were presented in arithmetic. They might have adopted the same mode of procedure. There were many elements in the other situations which, compared with the situation in arithmetic, invited either neatness or its opposite; but these other situations were not recognized by the children as inviting the same treatment as the arithmetic papers, and the mode of procedure, although it was possible, did not carry over into the new situations.

Power of Generalization *versus* Identical Elements

In the same fashion we may show that the principles of intellectual economy which Thorndike frequently includes in his statement of indentical modes of procedure, namely, the principles that one can learn to avoid distractions of all sorts, or that he can refuse to give up a piece of work even when it is uncomfortable, represent generalized identities of procedure which are not always realized. In all these cases we must distinguish sharply between the possibility of identical modes of procedure and the actual achievement of this identity. Such an achievement depends upon the exercise of trained intelligence. The existence of possible modes of procedure does not lead inevitably to their realization in fact.

Another illustration is of exactly the same type. A great deal of our reasoning involves the principle which has been clearly stated in the logics in the formula that every effect has its cause. Whoever becomes conscious of this general logical principle will find that in many different situations he depends upon this fundamental mode of explanation for

his scientific thinking. The little child undoubtedly is influenced very early by his experience to look for some cause for every effect. For example, the little child who hears a noise always looks for the source of the noise. If he sees a missile flying toward him, he always looks for the source of the missile. Gradually he falls into the habit of looking for causes for all effects and for effects of all causes. He could not formulate the fundamental principle back of these experiences in any definite terms, but he undoubtedly does come to assume a general attitude which is the background for the later logical formula that all effects must have their causes. There is, indeed, an identical element of causal relation in every possible situation. In this sense of the word we might say that all thinking is absolutely bound together by the presence of an identical principle. The degree to which the student will become aware of this common principle in all thinking will differ according to his training. The little child looks for fantastic causes for effects which he observes, and we say of him that his power of causal reasoning is very immature. The savage, as we have seen in the discussion of scientific thinking, tries to invent explanations; but he indulges in very free and uncritical imaginations. It would be very difficult to relate his mode of thought to the causal principle of science. It would be interesting to inquire how far a savage's mode of explanation of the physical facts about him is influenced by purely accidental elements, and how far by the demand for causal explanation which he possesses in common with all mankind.

Generalized Modes of Thought and Behavior

There are also certain identical elements of personality involved in every situation. When I view the world from my point of view, I import into every experience which I

pass through a certain mode of observation and a certain mode of thought which grow out of the totality of my earlier contact with the world. James has described this by saying that every human being is a bundle of personalities. At one moment one thinks of the world from the point of view of his business; a little later he will look at the world from the point of view of his social engagements. In these two cases he will be dominated in his thought by the point of view which he is at that moment assuming. All business transactions are thought of in a world of experience which is made up of the sum total of the individual's past contact with business affairs. We may say, therefore, that every individual brings to every new situation which he encounters the identical sum of his past experiences. This sum of past experiences will from time to time undergo enlargement and change because every new experience enters into the sum and contributes to a change in the individual's personality. There is, however, in a very proper sense of the word a nucleus of permanent experiences which must be reckoned with in any educational development. The child who has gone through the hands of a certain teacher carries away the stamp of that teacher's training; and every other course which he takes up will bear the impression of this earlier training. There is not a school in the country that does not testify loudly to the fact that a bad teacher in one of the lower grades will leave so serious an impression upon the class that has gone through the hands of this teacher that later instructors will have difficulty in overcoming the bad effects. It is fortunately true, on the other side, that an excellent teacher leaves behind methods of work and ideas about work which are of very great advantage to the students in their later studies.

The Author of the Doctrine of Identical Elements finds it Inadequate

When one begins to define the identical elements of a situation in these broad general terms he sees that the formula, identical elements of experience, is absolutely worthless. One is tempted to confirm this general position by quoting from Thorndike's own mature conclusions [1] in the matter where he says:

> The general theory of identical elements — that one ability is improved by the exercise of another only when the neurones whose action the former represents are actually altered in the course of the exercise of the latter — is sound, and is useful in guiding thought. However, so little is known about which neurones are concerned in any ability that this general theory does not carry us far.

On the other hand, one is convinced as he considers carefully this general doctrine of identical elements that one of the most important considerations in any system of training is to help students to discover the possibilities of generalization presented in successive situations. For example, mental economy is possible in a great variety of cases. Let us practice mental economy now under this set of conditions, and now under that. Again, the facts which are accumulated in a course in physics are capable of being carried over into the world of mechanics and the world of practical affairs. Let us take these facts, therefore, and see how far they can be generalized and made useful in all of the different spheres of experience. The problem of education thus turns out to be the problem of generalizing experience.

[1] Educational Psychology, Vol. II, p. 417.

Generalization an Achievement of the Active Mind

There can be only one conclusion drawn from the foregoing discussions: There is no inherent reason in the psychology of the individual mind or in the psychology of any subject of instruction for supposing that experience cannot be generalized. On the other hand, there is no reason to assume that experience of any type will infallibly carry over into any other sphere whatsoever. The generalizing of experience is a qualitatively new fact wherever it appears. Given experience A and experience B, the transfer of effects from A to B is just as much a new psychological process where it occurs, as were A and B when they first appeared in experience. To think of A and B as related because they exist is to fail to understand the psychology of generalization. Everywhere in human experience there are large possibilities of generalizing experience, and everywhere in school there is danger that experience will be narrowly specialized.

Formalism means an Absence of Generalization

This conclusion can be reënforced by studying what is really criticized when one uses the term "formal" as a term of condemnation in describing educational efforts. One goes back, for example, to the period of instruction in the classics when extreme formalism obtained in that study. What do we mean by the statement that extreme formalism appeared? We mean merely that there was no possibility of utilizing the results of that classical study in the life of the student. The study was a closed domain of experience, useful only in carrying the student around a narrow circle of exercises which terminated in more exercises of exactly the same sort and never stimulated the student to go out in further investigation

of the world. A subject which gets itself so organized that it rotates around its own center immediately becomes formal.

Attention has been drawn to the fact in the discussion of manual training that even a course in handwork may become formal in the same extreme sense in which a course in the classics becomes formal. A course in mathematics may become formal or a course in science may become formal. There is nothing that is more stereotyped than a course in botany taught by an instructor who does not see the opportunity of generalizing the results of this science.

Over against the formalism which is possible in every subject, there is the possibility of generalizing all sorts of training. We may express this in terms of an earlier discussion by saying that every science and every subject taught in the schools may be made productive because of the higher forms of mental activity which are stimulated by the study itself. If one can have his interest in number enlarged by each progressive step of mathematical study, he will be carried forward in his mathematical studies in such a way that he will find new applications for the principles which he has learned. The opposite of formalism is not emphasis on content, but emphasis on application. Any content may become formal. Any mode of procedure may become formal. Opposed to "formal" is such a word as "vital." That is not formal which moves forward to new applications. Generalized knowledge is not formal. Knowledge which is being used in applications, either in the evolution of higher thought-processes or in the solution of practical problems, is not formal.

Application as a Form of Generalization

The application of a body of information to a particular situation has sometimes been regarded as psychologically identical in character with the possession of this information.

Thus, it has been assumed in much of our school practice that if a student knows the principles of mechanics he will be able to discover these principles in operation in the ordinary facts of everyday life. This expectation is, of course, not justified. The boy who learns physics in the laboratory goes out into the workshop and passes many practical situations in which the results of his physics would be applicable, but fails utterly to recognize in these situations the physical laws which he knows in an abstract way. The school has undoubtedly been remiss in its attention to the phase of mental life which we here call application. Application is, however, a most difficult mental process, and needs to be learned just as the original principle itself has to be learned.

One of the methods by which one learns to apply experience that he has acquired is by the careful analysis of a large number of situations, and by a statement in connection with this analysis of the fundamental common principle which appears in all of the different situations. Thus, when we find the principle of gravity operating in one experiment in the physical laboratory, and then turn to a second and third experiment where the same principle is exhibited, we are preparing to isolate from these various different situations the common facts of gravity. If the student can be interested in discovering this common principle in a great variety of situations, he will have a type of mental attitude which is different from that which he cultivates in merely contemplating a single fact.

Successive examples, therefore, should be treated as the opportunity on the part of a teacher to cultivate the attitude of application. The cultivation of this attitude will be defeated if the instructor starts out with the explicit statement that each of the cases to be submitted contains the particular factor under discussion. Thus, if one gives fifty examples of the first law of mechanics, and explicitly states

at the outset that these fifty examples are all manifestations of that first law, he will not give his students the same degree of training that he would have given if he had mixed these examples with examples of the other laws of mechanics, and allowed the student to discover which of the laws of mechanics appears in each case.

Application has Many Forms

In the same fashion, in algebra it is a fundamental mistake to give to students all of the examples under a given principle with a definite statement to the effect that all of these are examples of a single type. The student fails to get the mental training in this case which is desired. He merely cultivates a kind of dexterity of manipulation which is very far from a genuine application of a scientific principle. Students leave school without the ability to make applications as a separate mode of mental activity. The teacher ought to recognize in all of these cases that the mere solution of the problem is of slight importance if the student does not acquire that higher power of discovering the mode of procedure which is appropriate in each case. The solution of the problem is mere routine. The classification of the problem is a form of generalization.

In the same way we may consider the possible extensions of any course of language study. If Latin is taught merely for the purpose of making it possible for the student to read some of the classical texts, the subject has a very narrow range of application. On the other hand, Latin may be taught with a view to stimulating students to consider the civilization which utilized this language; and still better, it may be taught in such a way that one comes back to a consideration of his mother tongue with the enriched experiences that he gains through his study. Finally, if the student not only realizes that Latin and his mother tongue have

certain common structures, but learns also that language in all of its development is an expression of a clear mode of thinking, and that he can become more lucid in his thought-processes by mastering this instrument of thought — then the applications of Latin become highly productive.

Generalization the Highest Aim of Instruction

Generalization of ideas and extension of any subject to its possible applications is, therefore, a larger and more significant aim in education than mere training in any given particular subject. Those who have opposed the doctrine of formal discipline by saying that the school subjects at the present time do not give a generalized training are undoubtedly criticizing not the human mind, but our methods of instruction. It is, indeed, possible to find courses in arithmetic and algebra which are so narrowing in their effect upon students' minds that it is doubtful whether they ought to be included in the course of study at all. So long as narrow-minded teachers are put in charge of these courses, and especially if teachers become imbued with the idea that their only business is to cultivate a narrow and limited function of mind, we shall have examples of these pedagogical failures which in the statistics show that training has not been transferred.

On the other hand, there has been a very large body of experience which makes for the conclusion that any subject properly taught has a broadening influence upon the student's general experience. The older subjects of the curriculum have so long served the purposes of instruction that they have cultivated a form of treatment and body of material which generation after generation has come to appreciate as a suitable vehicle for the general training of the mind. These older subjects have a distinct advantage over the newer subjects, which are still trying out the subject

matter which they utilize and the methods of presenting this subject matter. Until the newer subjects have mastered the problem of selecting material they will never be equal to the older subjects which have been worked out by generations of teachers. It is always safe to assume that the older subjects have more possibility of successful employment in the school for any purpose of education than have the new and untried subjects, the contents of which have not been worked over by experienced teachers. That the newer subjects should be able to impeach the older subjects of frequently lapsing into formalism is not to be wondered at, because it is certain on the simplest calculation of chances that the older subjects which have been widely utilized in the schools will exhibit more pedagogical failures than the newer subjects which have not yet been tried out. But there is no adequate justification for the loud contention of the newer subjects that the older subjects of the curriculum are inherently formal and of necessity narrow in the effects which they produce on students' minds.

Generalization appears in Many Forms

There is one further psychological discussion which is important in concluding this treatment of formal discipline. Bagley[1] and a number of other writers have contended that the transfer of training always depends upon the conscious recognition by students of the possibilities of carrying over an ideal from one course to another. The statement that a generalization must come to explicit recognition goes too far. A study of the facts of mental development reveals many different forms and stages of the process of generalization. For example, the student who discovers a

[1] W. C. Bagley, The Educative Process (The Macmillan Company, 1905); also E. N. Henderson, Textbook in the Principles of Education, p. 213 (The Macmillan Company, 1910).

general principle in physics may get his principle in one of two ways: he may either have the principle presented to him in a definite and conscious form, after which he seeks illustrations of the principle in various facts which he encounters. This is commonly known as a deductive method of teaching. Or, on the other hand, the student may equally well be brought to the general principle through contact with a number of concrete cases. He now sees this case and now another. He learns to adjust himself in each of the particular cases without making at the outset any complete analysis of his experience.

Practical Judgment as an Early Form of Generalization

Hobhouse[1] has described in his discussion of practical judgment the stage of mental development which precedes the full development of conscious principles. Practical judgment for Hobhouse is a mode of generalization in which the individual becomes aware of certain aspects of the world without making a complete conscious analysis of his different experiences. As a result of practical comparisons one carries over modes of behavior from situation to situation. This carrying over of experiences without complete analysis appears in a large way in all the minor adjustments of life. In social matters, for example, having cultivated a certain attitude toward a given individual, one is likely to behave in the same general way to everybody who vaguely reminds one of the original person for whom the mode of behavior was cultivated. One becomes in the course of time suddenly aware of the reason why he behaves toward his new acquaintance as he does. The reason is that this new acquaintance resembles in some general way people who have in earlier experiences been the subjects of certain

[1] L. T. Hobhouse, Mind in Evolution. The Macmillan Company, 1902.

types of behavior. If now we can bring the individual to the level of clear conscious analysis, we very frequently see that the rough analogies on which we have been depending are wholly inadequate; that is, the individual whom I have been treating in an agreeable way because he resembled a friend may turn out to be an individual wholly undeserving of this attention on my part. The conscious ideal or the complete analysis of the situation then interrupts a mode of adjustment which has been going on in a general way without any clear knowledge on my part of the reasons for this mode of adjustment. Conversely, if I have been treating a person badly because he looks like one of my enemies, I may on discovering the real reason of my attitude suddenly find that I ought to revise this attitude. The earlier stages of such situations can be described as stages of practical judgment of a rather crude and indefinite sort. To say that all transfer of attitudes depends upon clear and conscious ideals is to fail to recognize these early stages of practical judgment. It would be more in keeping with the facts to say that we rely on all sorts of practical judgments until some failure makes us aware of the inadequacy of our vague generalizations. Then we cultivate a higher form of generalization.

Language an Instrument of Generalization

The discussion of generalization in the chapter on science brought out the fact that in many cases generalization is dependent on the use of words. There can be no doubt that this fact was one of the chief considerations which led Bagley to his doctrine of transfer through conscious ideals. When a child is led to see, through the use of words, that various situations are all capable of one identical treatment, he discovers what he would otherwise overlook, and generalization is greatly aided.

On the other hand, as has been pointed out repeatedly in all the discussions of language, the student may be led away from true generalizations into mere substitutes for generalizations by words. This is the reason why ideals which are expressed in words are often very formal in character. One may tell a student, for example, that he ought to concentrate his attention, and he may have the theoretical ideal of concentration well in mind and yet be quite unable in practice to realize the advantages of this ideal. What is needed in this case is a real generalization or a translation of his verbally recognized principle into an actual mode of behavior. This translation into an actual mode of behavior very frequently differs so radically from the recognition of the verbal statement of the principle that the student may be fully aware of the principle in one form but altogether unacquainted with it in the other. Even then the verbal principle may be a useful means of education. Thus, when one is told to concentrate his attention he will try first by one method and then by another. He will withdraw himself from all sorts of distractions. He will read out loud in order to facilitate the concentration of attention. He will wrinkle his forehead as Fechner indicated that he always did when he was trying to concentrate attention. He will sometimes adopt devices that seem to an onlooker to promote distraction rather than concentration, such as beating a rhythm with his fingers on the desk, or whistling, or stamping his feet. These different devices adopted by the student who is trying to concentrate his attention are very difficult to relate to the general verbal formula, and yet the steady holding of the verbal formula before one's mind may lead one to try a great variety of experiments in the concentration of attention. Ultimately these experiments may result in the adoption of some practical mode of procedure which will satisfy the formula with which one started. The verbal formula in this case is not to be regarded as the actual

habit to which it relates, but it is a kind of stimulus or a kind of reminder that one ought to seek continually some habit of concentration. To say that the transfer has taken place in this case through a conscious ideal is to fail to recognize the fact that the value of the verbal formula is that it is of such a general type that it can stimulate in a great many different cases the development of a great many different kinds of detailed procedure. Thus the concentration of attention when one is reading may be wholly different from the concentration of attention when one is listening to music or to a lecture; and yet the effort to concentrate attention in these different cases may be promoted by the presence in the mind of the student of the verbal formula that he must pay as close attention as he can.

Language itself a Generalized Mode of Behavior

In general, as has been pointed out in earlier discussions, language is a general mode of behavior capable of connecting itself with all sorts of particular habits. It is a kind of generalized sphere of action, and as such a general sphere of action it becomes an influential element in all sorts of situations. It is indeed a common element of all of these different situations, but it is a common element in the sense that it is a higher type of adjustment than any particular mode of procedure. As such a higher type of procedure, it reaches down into a variety of concrete situations. Its value arises from the fact that it is a general mode of behavior.

Emotion a Form of General Behavior

There are other general modes of behavior besides language. For example, one of these general modes of behavior which is of a good deal of importance is the emotional reaction of the individual. We speak in ordinary life of the

optimistic attitude of an individual, and we have every evidence that the optimistic attitude is a favorable attitude in whatever particular line of accomplishment the individual expresses himself. A person who is constantly optimistic will undertake all sorts of enterprises in a spirit of energy and enthusiasm which is wholly different from that exhibited by a pessimistic individual. There can be no doubt that the skillful teacher should be interested in the cultivation of such favorable general attitudes. The failure of teachers to appreciate the value of optimism appears at times in the fact that they correct the student so frequently in classes as to develop an expectation on his part that he is going to fail in everything that he tries to do. The withdrawals from school which are so characteristic of the earlier years of the high school are connected in no small measure with the unfavorable emotional attitude aroused in the class exercises.

These general emotional attitudes may attach themselves to all sorts of particular situations. Thus, one may be optimistic about getting a Latin lesson or he may be optimistic about a game of football. He may be optimistic about a business venture or he may be optimistic about the movements of his political party. In any case he will react in each of these situations with a general organic vigor which is represented in his own experience by the pleasure that attaches to his reaction. It cannot be stated that the emotional reactions in the various manifestations of optimism are identical in detail, because all of our psychological analyses go to show that the pleasure which comes from the solution of a problem of an intellectual type is different from the pleasure which comes from physical exercise. Yet the two are of the same general type; and both represent a kind of organic vigor and a mode of organic reaction which becomes typical of the individual and characteristic of all his behavior. This kind of example serves also to reënforce

what was said a few paragraphs above with regard to the importance of personality as the central element in all sorts of situations. There is nothing more typical of one's personality than his emotional moods and his general reactions of optimism or pessimism.

Intellectual Methods which are Generalized

Further examples of general reactions will be discovered if we analyze the typical school situations in which an effort is made to cultivate general habits. Take, for example, the series of exercises which are used in the algebra class to make a student thoroughly familiar with a given principle of factoring or a given mode of procedure in multiplication or division. One may say that the various exercises which the student works out are intended to acquaint him with the same mode of procedure as it appears in a variety of different connections. He uses a certain principle of factoring now in one situation and now in another, or he uses the process of multiplication now with one combination of letters and now with another. The common fact in each of these different situations is the mathematical process as distinguished from the actual recombination of the particular elements that enter into the special exercise. From the point of view of the mathematician, there is a common element in all of these situations; but that common element is a general principle, which general principle and general mode of procedure must be discovered after one has solved a number of the particular situations in which the general mode of procedure occurs. The general principle to be comprehended is not a part of each one of the situations. It is the product in the individual's mind of a comparison of all these different particular cases. It cannot be said that the general mode of procedure appears in case one and case two and case three, or that it is

something which can be detached from each of these cases and looked at as a common element. The general principle arises from the comparison of case one with case two and case three. The power of making this comparison and of arriving at a general mode of procedure is a higher power than the power of solving the particular problem. This fact, that the recognition of the general principle is a higher type of power than that which is involved in the solution of particular problems, appears again and again in the training of students. There are many students who know how to solve a problem if they are told which process to employ, but they do not know enough about the problem to select the process which is appropriate to the situation in hand. The mastery of the general principle is therefore a new type of mental achievement.

In the same way the student discovers a general principle of language structure when he learns, for example, that all nominative cases have certain characteristics. He is not merely taking an element that appears in one example of the nominative case, and in the second example the same sort, and so on, recognizing an element common to all of these different situations; he is learning rather to extract from a variety of experiences a general principle or rule. The discovery of this general principle or rule is a new performance; it is an expression of the power of generalization. The cultivation of this power of generalization is the most important achievement in the student's education. It will not come without special endeavor on the part of the student and on the part of the teacher.

Methods of inducing Generalization

The same conclusion is reached if we examine some of the practical methods which are adopted in school work to induce students to generalize their experiences. Undoubtedly

one of the most advantageous methods that can be employed is to give students a verbal statement or conscious ideal as Bagley suggests. A verbal formula which will stimulate a student to strive on various occasions for concentration of attention is a suitable instrument for the teacher to employ in developing concentration. On the other hand, the teacher knows full well that the mere presentation of this verbal formula is not enough; consequently he devises situations which he presents to the student with a view to furnishing him the opportunity of applying his verbal formula and making generalizations. These situations ought to be organized in such a way that it will be relatively easy for the student to make a generalization. Sometimes the generalization can be reached by the comparisons of a number of cases. Every teacher is aware of the value of a comparison as a means of training the student to arrive at generalizations of his own. For example, if one wishes to get the general meaning of a foreign word clearly in the mind of a student it is always advantageous to compare the word with certain synonyms. The purpose of this comparison is not to bring out an identical element which appears in all cases. Very frequently the purpose of comparison is to bring out unlike elements. In the same way, if one is working on the scientific description of an animal in zoölogy or a plant in botany the most impressive lesson can be derived from comparison and contrast. The use of the terms "comparison" and "contrast" shows that generalizations very often deal with something besides common elements in different situations. There are discoverable relationships in all of the different situations, but the discovery of a relationship which can be regarded as a general element of a variety of different situations is a new achievement. Suppose, for example, that one wishes to show that the structure of an animal that lives in water is very different from the structure of an animal that lives

something which can be detached from each of these cases and looked at as a common element. The general principle arises from the comparison of case one with case two and case three. The power of making this comparison and of arriving at a general mode of procedure is a higher power than the power of solving the particular problem. This fact, that the recognition of the general principle is a higher type of power than that which is involved in the solution of particular problems, appears again and again in the training of students. There are many students who know how to solve a problem if they are told which process to employ, but they do not know enough about the problem to select the process which is appropriate to the situation in hand. The mastery of the general principle is therefore a new type of mental achievement.

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in the air. The contrast between the two cases will lead directly to generalizations about relations of function to structure which could not be secured if all of the animals were of a single type. In the same way, in discussing geometry it has been found advantageous to contrast the space which we know with such hypothetical space as the non-Euclidean geometricians devise for the purely theoretical purposes of contrast. Here the mind creates a situation for the purpose of aiding contrast rather than for the purpose of discovering similarity of elements. As was pointed out in the discussion of the study of foreign languages one of the most useful functions of this study is to supply a student with a background for the application of his mother tongue.

Attention to Generalizations a Product of Instruction

There can be no doubt that all the efforts of the school to induce generalization lead to an attitude of mind which can be described as the generalizing attitude. Wherever a student has seen the possibility of analyzing various situations and discovering productive relationships between these different particular situations, he will be stimulated to treat new problems in the same way. He will see the possibility of analyzing everything that comes into his experience for the purpose of discovering general principles. We have here a broad habit of mind which is undoubtedly very largely promoted through the use of language as a generalized mode of reaction upon all situations. The habit of verbal analysis is a general habit dominating all of the detailed habits of mental life. In our discussion of scientific method we have pointed out the fact that there is such a generalized habit of scientific analysis which can be cultivated through the study of all of the sciences. The only

additional remark which needs to be made at this point is that the teacher must explicitly cultivate this general habit.

Farewell to Critics of Formal Discipline

In conclusion, we may be permitted to set the teachings of this chapter in as sharp contrast as possible with the position taken by those who teach a doctrine of specialized mental functions. This chapter is intended to teach a doctrine which is diametrically opposed to the following principle announced in 1905 by Thorndike in his "Principles of Teaching," p. 248:

> Training the mind means the development of thousands of particular independent capacities, the formation of countless particular habits, for the working of any mental capacity depends upon the concrete data with which it works.

Or, putting the matter in another way, this chapter is intended to prevent the violent oscillations described by Thorndike in his "Educational Psychology," published in 1913 (Vol. II, pp. 364–365):

> The notions of mental machinery which, being improved for one sort of data, held the improvement equally for all sorts; of magic powers which, being trained by exercise of one sort to a high efficiency, held that efficiency whatever they might be exercised upon; and of the mind as a reservoir for potential energy which could be filled by any one activity and drawn on for any other — have now disappeared from expert writings on psychology. A survey of experimental results is now needed perhaps as much to prevent the opposite superstition; for, apparently, some careless thinkers have rushed from the belief in totally general training to the belief that training is totally specialized. In any case, such a survey is the safest preparation for deciding theoretical or practical questions concerning the effect of the improvement of any one function, in school or out, upon the efficiency of other functions.

CHAPTER XVIII

TEACHING STUDENTS TO STUDY

Teachers not Equipped with Method of Training Students to study

The theme of this chapter can be illustrated by an example given the writer by a high-school principal who is much concerned with the problem of teaching students how to do their school work efficiently. He has so organized his school that one period a day is set aside for consultation between each teacher and some class. During the last period of the day on every Monday the teachers meet the classes which in the daily program recite during the first period of the day; on Tuesdays, during the last period, classes go to the teachers who have charge of their recitations during the second period of the day; and so on. When the teacher and the class meet in this additional period, it is not for the purpose of an additional recitation; the purpose of this period is to direct students in the methods of getting their lessons efficiently and economically. The program above described was arranged and the classes met the teachers. Then it was discovered that the teachers did not know what to say to the students. Teachers know about Latin and mathematics. They can ask questions in these subjects; but they do not know about students' minds in a way which makes it possible to tell students how to study.

One becomes most acutely aware of the problem of method of study when a student is in difficulty. How shall we help him out of his difficulty? Yet the more important problem is to make increasingly efficient those students

who are not in difficulty. Most teachers do not realize that good students need help in methods of work. The result is that a teacher confronted with a class which he has met that morning in a Latin recitation, and told that his duty in this second period is to teach not Latin but the methods of study, stands dumb and embarrassed. If someone fails in a Latin construction, this teacher can tell him the correct construction. If someone uses a clumsy Latin phrase, the teacher knows Latin enough to suggest improvement. When it comes to improving mental processes, how different the case! The teacher has little training.

Psychology as Science of Methods of Study

This is the point at which the student of psychology finds his opportunity to review what he has to say in his discussion of the psychology of the various subjects. The psychologist deals in mental processes and difficulties. He knows neither Latin nor mathematics except as content for mental processes. He is therefore eager to impress on the Latin teacher and the teacher of mathematics the desirability of becoming psychologists as well. The following pages will be devoted to the effort to set forth in a concrete way the kind of considerations which a teacher might take up with a class which he meets for the purpose of discussing the problem of how to study. Some of the illustrations will be drawn from the earlier chapters of this book, some from classroom experiences.

Psychology of Different Types of Study

First, attention may be called to the fact that a sharp contrast can be drawn between studying by one's self with the aid of a book and studying with the coöperation of others, as, for example, when a class as a whole reads a book

and considers its contents in conference. The student who sits down alone with a book does not have in his own personal experiences the same number of questions about the meaning of the text or the same number of ideas growing out of his reading of the text as would a group of people. While one individual reading a book sees in the text difficulties or suggestions, two individuals will have, possibly, not twice as many questions and suggestions, but certainly more than the single individual would have. Therefore, when two people read a book together they may help each other by raising questions which represent two different individual points of view. It would be very valuable for someone to set the same lesson to be studied, first by a class that took it for home work, and, second, by a class that read the same book over with the teacher and with the other members of the class. After these two different types of study, an investigation might be made of the differences between the points of view cultivated and the completeness with which the information was criticized.

The foregoing paragraph also suggests that different kinds of subjects need to be approached in different ways. For example, it might be very profitable to study a history lesson or a geography lesson with the class as a whole; on the other hand, the study of a lesson in spelling might better be undertaken by the individual without the coöperation of the class. Or perhaps the last example should be modified so as to call attention to the fact that if the class as a whole studies the spelling lesson the method of procedure will be one of discussion of the different words rather than a concentration on the individual words, whereas if the student studies the words by himself he is likely to give himself up to the exact memorizing of the words rather than to their discussion.

Rapid Survey

A second general topic which it is important to discuss is the distinction between a careful analytical study of a subject and the development of a general point of view by rapidly reading over a body of material. For example, the student who is given a passage in history to learn may advantageously read the whole section that has been assigned to him at a single sitting, for the purpose of gaining a general view of the subject, and then he may come back to the detailed examination of the particular incidents that enter into the full description. Evidently a general reading of an arithmetic lesson or a lesson in algebra would be less productive. In some cases, however, a general reading of the whole lesson might be advantageous even when the lesson is of the type that one finds in algebra; but here the successive stages of any topic depend so much upon a clear comprehension of everything that has gone before that it is probably not desirable for the student to emphasize the whole until he has mastered the successive steps of the reasoning.

Undoubtedly the attitude of a minute study of each individual sentence is sometimes carried to an extreme. The student puzzles over the exact meaning of a certain sentence when the exact meaning cannot be understood except in the light of fuller exposition which follows later in the paragraph. This puzzling over a single sentence consumes much time, and leads to a mental habit of distracted thinking which is opposed to the interests of rapid assimilation of large bodies of material. The student should be trained both in careful analytical study and in general study of whole passages, but the two types of training should not come at the same time.

The rate at which a student assimilates material is a matter of importance. It is not desirable that he should be

hurried in his mental processes, otherwise he is likely to become confused. If he is told that he must get a thing done in a limited space of time, this very requirement is itself a subject of attention. The student is constantly distracted by looking forward to the end of the lesson, and is therefore unable to take the successive steps of the reasoning without distraction. On the other hand, it is a mistake to allow a student to develop habits of excessively slow reasoning and slow study. He should be encouraged to work, while he works, at a maximum rate. One of the simplest ways of securing this maximum rate of study is to give explicit training in the mastery of short sections of a subject where the confusion from the demand to work rapidly will not be great. Let the teacher set, under his own guidance and supervision, a short paragraph and ask the student to get it as soon as possible. The task of concentrating attention at a high level for a brief period of time does not make an excessive demand on the student's powers; and if he finds that he can do this for short sections, the sections may gradually be increased in length.

Observing Methods of Study

One of the best opportunities for observing the way in which students do their work is in the study period. If the teacher will acquaint himself with the sections in the book which the student is supposed to be studying and will form a rough, general estimate of the length of time that is necessary for the reading of a page of printed matter, he may then watch the student and see whether he is reading at a reasonable rate. Very frequently it will be observed that the reader turns away from the book and looks out of the window or does something else, indicating that he is distracted from the reading itself. Sometimes this turning away from the book indicates a genuine thought-process.

The reader gets an idea from the passage and stops to consider the value of the idea. In general, in an immature reader this is not a fact. The turning away from the book is an indication of an interruption rather than of the working out of an idea.

Careful observation of different individual students will undoubtedly bring out the fact that some students are able to concentrate for a longer period of time and to do their work at a higher rate of speed. If the teacher can learn to discriminate in this way between the different members of the class, he or she can later concentrate attention upon those who do not know how to stick to the problem. Here again the best method is to help them to concentrate attention on short passages.

The mere social desire to get things done as rapidly as somebody else can be used in this connection. Certainly there are some subjects where social emulation can very properly be employed. Thus, in simple mathematical exercises it is proper to get up speed by competition. This speed should not be cultivated in such a way as to excite students too much. There is danger, if a speed exercise is continued for ten minutes, that the excitement will become too intense. On the other hand, a little excitement for a short period, say through a five-minute exercise, is entirely legitimate and desirable. In the same way, speed exercises in silent reading are entirely legitimate and should be undertaken from time to time. The habit of oral reading, and reading at the rate of oral reading, should be corrected by giving definite exercises in rapid silent reading.

Asking Questions of People and of Books

Another important problem in learning how to study is to learn how to get information from books. The student should have the matter explained to him in some such

terms as these: If one needs information and goes to some other person and asks for it, he can keep on asking the person questions until a method of answering is adopted which the questioner can understand. On the other hand, if one goes to a book and insists on getting the information in just the form in which the question is present in one's mind, he is not likely to find the exact answer to his question in the book. The way in which one has to get information out of the book is to learn to use the book in its own way. Perhaps the information which one wants is scattered over three or four pages. Possibly it is to be found only by consulting two or three different books. Asking questions of books, therefore, consists in getting one's self trained so that he can get from the books what he wants by looking at the different places in the book where the different parts of his information are to be found. Very frequently one has to read in the book many things that he does not need for the answering of his question. In this respect looking in a book is not altogether different from asking a person questions. One very frequently gets more information than he needs when he asks a question. The one who answers starts out to give the answer, but he includes several other things. The listener must learn to make a selection from among the things he hears if he is to concentrate his attention on the particular items wanted. In like fashion, if one consults a book with a question in his mind, the answer which he seeks must be secured through a careful, selective reading just as in the case of personal inquiry; but here, in addition to selecting from an oversupply of information, one must know the technique of going through the book. Getting answers to a question is in any case different from the process of merely learning straight ahead what is in the book or what is given to one by someone else's dictation. When one reads straight ahead in a book and gets the information that is there

presented, he follows the lead of someone else. He tries to formulate his thinking along lines laid down in the book. The difficulty with this process of simply following someone else's lead is that very shortly one comes on a sentence or a statement which he does not understand. He is then obliged to ask some sort of a question in order to clear up the difficulty. If he does not know how to ask that question, or if he is not alert enough to see that failure to understand the passage ought to lead him to ask a question, he becomes confused and unable to go on with his work. Students are often confronted by difficult passages, and they do not know what to do with them simply because they have not been trained in the course of their earlier work to ask questions about difficulties and to find answers to these questions. It is highly important, therefore, that students should be trained to ask questions and get answers.

Formulating Productive Questions

One important part of instruction in any course should accordingly be to get the students to raise questions about the subject under discussion. It would be an excellent practice to require the class to formulate questions about each lesson. Some of these the teacher could answer directly, thus exhibiting the importance of social relations and social methods of getting information. Some of the questions should not be answered by the teacher, but should be given back to the class as problems to be solved.

Assuming that a question has, in some fashion, been raised either by the teacher or by some member of the class who encounters a difficulty which he does not readily overcome, there should now be a careful consideration of the methods of getting answers to this question. The first and readiest method has already been suggested. Let someone who has the information in his mind and sees the point of

the question give an answer. Very frequently an answer will be given which does not entirely cover the question. It is interesting, then, to subdivide the question to show that the answer given is a partial answer. Finally, the class will be brought to the point where no one has exactly the information that is needed to answer a part of the question that has been asked. One must now turn to the more elaborate authorities for this answer. The methods of turning to these authorities should be taught. The teacher can very frequently give the necessary method by teaching students to turn to other parts of the textbook which they have in hand. Thus a student who is in difficulty with a problem in algebra ought to be taught how to turn back to the early parts of the book and get the answer to his difficulty. Turning back to the earlier parts of a book may involve turning to the table of contents. Another way of turning back to the earlier parts of the book is to look over rapidly all of the matter which is contained in the first part of the book. Students should be shown that it is not difficult to run through fifty or sixty pages of a book in looking for an explanation of a difficulty which is encountered in the latter part of the book. Indeed, one ought to get into the habit of looking through all sorts of books and getting a general impression of what a book contains even before one studies the details of the book.

The Discovery of Problems

The foregoing paragraph suggests a most important phase of the studying process. Students should realize that one of the important interests in mental life is the discovery of problems, not merely the acceptance of answers to these problems. Wherever there is a deficiency in the information which the student has, he ought to be aware of that deficiency just as much as of the positive information which

he gets. For example, if a student is reading in a history lesson and comes to the fact that while the United States was passing through a certain series of events England made such and such a representation to our government, the question ought instantly to arise in his mind, Why was England interested in making this representation? This question, in turn, should raise in the student's mind the general question, What was going on in England at the same time? Very frequently our histories are one-sided because the students do not go beyond the statements in the text itself. They do not realize that these statements are only a part of the whole story of the world's doings at that time. Ability to formulate this additional question and, in consequence, to see that one needs fuller information is the best possible training. There is nothing so disastrous in intellectual life as the attitude that one has all the information which he needs. As pointed out in an earlier chapter the scientific method has, as one of its most important elements, the habit of problem raising and problem stating. When the chemist realizes that there is something which he does not know, but which he must find out in order to apply his chemistry to industry or to later developments of the science itself, he has raised a question which makes possible fuller investigations.

Problems do not arise; they are discovered

It has been one of the favorite themes of recent educational writers to point out that problems are constantly arising in shop work and in industrial life. There is a certain fallacy in this statement. It is true that shop work presents the possibility of certain problems. It is true also that in industry certain problems naturally arise, but it is equally true, as has been pointed out in an earlier chapter, that in industry only the leaders recognize these problems.

The ordinary workman does not see the direction in which his work can be improved. He goes on in the regular routine, following the example of his predecessors without question and without ingenuity to make a change. As soon as one sees the possibility of looking into every industrial process and asking whether it is as efficient as it might be, he starts on a new line of development. This new line of development is of first-class importance to industry, because it means that the attention of the man who has raised the question will be directed toward new answers to the problem that has always existed.

Exactly the same statement can be made about school work. We go on studying texts that do not answer all possible questions on the subject, simply because our mental habits have been chiefly the habits of accepting and following someone else's lead. Students are, in general, dominated by their teachers and by their textbooks, because these contain a great deal more information than the student can compass. The student is carried forward in the new fields of authority so rapidly that he is not stimulated to ask questions. He is too busy trying to keep up with the questions that are asked by his teachers. It would be very much better if we could lead him to see new questions. The probabilities are that he will not ask questions even in his shop work any more than the practical worker asks these questions in the ordinary course of industry. Anyone who has seen shop work in the schools realizes that it does not satisfy the expectations of those who hold that shop work stimulates originality and creates a need for scientific study on the part of children. The fact is that our educational method must be modified, with the explicit view of giving children an opportunity to create intellectual needs through the questions which they raise. It has long been recognized in our description of children's mental processes that they begin their school life with a natural feeling of these needs.

They ask questions with a good deal of freedom. The difficulty is that we do not know how to conserve that side of the child's natural mental attitude. We answer these questions in such a way as to seem to give a final answer to the child's needs, and we do not lead him to be keen about other possible questions of a higher order.

The Advantages of Group Study

One of the best ways to correct this difficulty is to allow a group of students to study a lesson together as indicated in an earlier paragraph. They will then stimulate each other to recognize difficulties and questions. If the lesson is recognized by the teacher and the class as a study lesson rather than as a recitation, the students can be made aware of methods that they ought to adopt in private study. The teacher who exhibits skill in this kind of an exercise has done much more for students than merely to train the memory.

There is no doubt at all that we are confronted here with one of the greatest educational problems — the problem of cultivating the intellectual initiative which is necessary to raise questions, as the first step toward training students in the methods of getting answers to their own questions by the long and difficult methods of self-directed study. In the higher institutions of learning we call this intellectual initiative "research." In the lower institutions we should describe it by saying that the student ought to learn first why he is expected to go to the library or to the laboratory or to the shop, or to some other source of information, and get a reply to his question. The value of an inquiry is very often in the appreciation which it brings of the problem solved. Thus the sixth-grade class which, in the study of geography, is led to see the possibility of observing the position of the sun in successive months is getting training

in scientific research which is of first-class importance. Such investigation through direct scientific experiments is often by no means the most economical method of getting an answer, though it is often the most vivid way of teaching both the question and the answer. What the student often learns most impressively from an experiment is that others have seen this problem before he saw it. He will then appreciate more fully the fact that they worked on it and solved it. He will thus be led to recognize more fully the significance of his ability to read, and by reading secure the help of others who have made scientific investigations.

One notices in his contact with teachers that there is in some quarters great respect for books, while in other quarters, books are regarded as of doubtful value. Some people are so absorbed in their ambitions to secure scientific work from the children that they regard it, on the whole, as very damaging to children that they should be brought in contact with books. The better attitude in these matters is for the teacher to recognize that there are several different methods of getting solutions to questions. The book method of getting a solution is a complex method which gives mental training, but it is a different method from that which the scientific investigator follows when he gets a solution through experimentation. Social discussion is still another method which can be employed. Whichever method is being used, the student should be trained not only to master this or that mode of procedure for getting his answers but, above all, to know how to formulate questions, and then to recognize the use of each of the methods of getting answers and the legitimacy now of one method and now of another.

Training in Economical Methods of Study

Another important matter in teaching students to study is to show them that there are certain principles of intellectual economy which ought constantly to be considered. Thus, it is a very bad investment of time to do over and over again in a superficial way a task which could be mastered, once for all, by giving a little more time to it than one naturally gives. One of the best arguments in favor of economy is to be found in the case of a student who wastes his time by looking up a word in a vocabulary every time he finds it in the text. Thus, in translating a Latin passage a student comes to a certain word. He turns to the vocabulary and finds that there are fifteen or twenty meanings given for this word. He runs his eye down the list of meanings and carefully selects the one that will serve his purpose. He tries to overlook the other meanings because they do not serve his purpose at the present moment. From one point of view this seems to be economical. One is trying to translate a given passage, and to stop and consider the meaning of a word in general will be distracting. Furthermore, our textbook vocabularies are frequently so made up that a student would be quite unable to get at the general meaning of the word by reading over the full statement given. Even the worst vocabulary that has ever been constructed would, however, if properly looked at, give some clue to the general meaning of the word, and offer some suggestions as to the reason why all of these different meanings are attached to the single root. If the student would stop, therefore, and read over the list of words in the vocabulary with a view not merely to selecting the particular meaning which he needs for the given passage but also with the view to recognizing the general character of the word; if he would pay enough attention to the word itself so as to form its

of algebra. There is no better exercise in any course than to encourage the student to prepare in a large way for future uses of the present lesson. Students should be taught to do this with a full recognition of the intellectual economy which they are thus securing.

Students profit by use of Standards

One of the methods which is of great importance in training students to study is the method of giving the student some standards which will help him judge of the success of his own work. S. A. Courtis,[1] in discussing his arithmetic tests, calls attention to the fact that these tests are of value to the individual student because one can train the student himself to judge of his ability as compared with his own past achievements and as compared with the legitimate expectations to be imposed on people in his class. If, for example, the student knows that the other members of a certain class can, on the average, complete a certain series of addition exercises in twenty seconds, he has a standard which he can utilize in his own practice. He can try to do this exercise in twenty seconds. If he succeeds in doing it at this rate, he knows that he has come up to the sixth-grade standard. Furthermore, he can be told that this is the standard required in business. If, on the other hand, it takes him forty seconds, he knows that he must drill himself more or he will be rated as backward. Furthermore, if he records the time which he requires every time he performs exercises of addition or other processes, he will be able to watch his own improvement. There is nothing so stimulating to a student as to see the rate at which he is improving. On the other hand, there is nothing

[1] "The Courtis Test in Arithmetic," Report of the Committee on School Inquiry of New York City (Part II, Subdivision I, Section D), Vol. I, p. 489.

so discouraging to a student as to be unable to determine whether he is making intellectual progress or not. It is for this reason that many a student becomes discouraged in his class work; he does not know whether he has a right answer or not, and is therefore greatly disadvantaged as contrasted with the student who has some method of checking up his results.

In a recent number of the *Elementary School Teacher*[1] a clever device was described by J. W. Graham for showing grade pupils whether they can add rapidly or not by asking them to add at the rate at which a pendulum swings. The pendulum is gradually shortened until the limit of speed is reached. The student knows from the length of the pendulum what degree of success he has attained in the adding process.

The Value of Standards in Self-Adjustment

It is fairly easy in such subjects as arithmetic to give the student some kind of a standard which he himself can adopt and follow. It is of course by no means as easy to give him similar standards in some other subjects; but he ought to be made aware of the meaning of standards. One device that can be adopted is to ask the student to rate himself in the degree of preparation which he has on a given subject. Get him, in the case of an examination, to tell how well he thinks he did his work, and help him check up his judgment by showing him how little this judgment comports with the actual results of his work as judged in the light of the work of the class as a whole. Call attention to the fact that the estimate which the student has of his own work differs from the estimate which he ought to have because he does not know how well others do their work. Show him that comparative standards are significant in

[1] Vol. XIV (1914), p. 348.

estimating one's own value in the commercial world or in the world of intellectual achievement. A student should know about how long he ought to spend in the preparation of a lesson. Individual differences must of course be taken into account, but it is important that the student should come to recognize some of his own peculiarities. If a student is a slow reader, he ought first to realize the possibility of improving the rate of his reading; and, in the second place, he ought to realize that it is going to cost him more time than it costs some other members of the class to get up his work. In spite of his individual peculiarities he ought never to be allowed to assume that his mental efficiency is satisfactory if he requires an indefinite length of time for the execution of a certain task. The teacher ought to know the time and effort required to master every assignment, and ought to be able to say to the class that the rapid members are expected to get the lesson in a half hour, the slower members certainly inside of an hour and a half.

If our educational work were thus standardized, it would be a very great advantage to both students and teachers. There would be no evasions between students and teacher with regard to the amount of effort that the students need to expend. There would be very much greater certainty in our definition of standards of institutions. At the present moment we turn a student loose on a certain section of a course and ask him to get it ready. The sections which we assign from day to day are very rough divisions, given out without exact knowledge on the part of the teacher as to the amount of effort which is required on the part of the student.

Progression a Test of Effective Training

Finally, the student ought to realize that the best check of his own work is his ability to go on with the next line of work. He ought to realize that the natural penalty of

failure at one point is increased difficulty in the next stages of the course. In order to make him distinctly aware of this relationship between different parts of the course, it will be necessary for us, first of all, to reorganize our education material in such a way that there shall be real progression in intellectual demands made upon the student.

Our discussion of standards for the student, therefore, leads us back to the problem of standardizing and systematizing our various courses. Heretofore our courses have been systematized from the point of view of the subject matter to be covered. Some courses have also, in a rough, general way, been systematized with reference to the difficulties of intellectual problems presented. It is assumed that the course grows more and more difficult as one goes forward to the higher stages of the subject. There is certainly no consistent development of this ideal type in many of the subjects of the curriculum. For example, in an earlier chapter attention was called to a conspicuous illustration of the lack of development in intellectual demands found in the courses in history. Often hard courses are purposely put near the beginning of the school work. For example, we very frequently have evidence that the algebra course in the first year is one of the most severe courses in the whole curriculum of the high school. The first science course which is given in a department is very frequently much more severe than the later courses in the same subject. Educational institutions very frequently point out the fact that the difficult courses at the beginning are intended to weed out the poor students. In the work in home economics, for example, it has frequently been the case that a severe course in scientific chemistry precedes a number of very easy courses in the practical art of cooking.

This failure to give a student any progressive series of requirements in the different subjects is a mistake from the point of view of the student's own intellectual habits.

Having mastered a given subject, the student feels the need of a progression of some sort in his own intellectual life, and the school ought to give him this satisfaction and also this test of his own earlier work.

Traditional Courses emphasize Progression

Latin and some of the other traditional subjects are undoubtedly in excellent form in just this respect and are better organized than the scientific or historical subjects. Furthermore, the nature of language development is such that accumulation of training comes as a necessary result of larger contact with the words and constructions which go to make up the language. If one has read a certain amount of Latin, he finds that it is easier for him to read the next Latin passage to which he comes. The acquisition of facility in reading Latin is thus a kind of natural indication to the student of his progress in the subject.

School Subjects require Psychological Analysis

The reorganization of all of our courses with this principle in mind will be worked out when teachers see the importance of making a definite catalogue of the intellectual processes which students cultivate. For example, suppose the history course could be organized in such a way that the demand made upon students in the earlier years of the history course were, first of all, for ability to comprehend a coherent narrative of successive events. Suppose that at this stage we did not demand any very large explanation of the events studied. Suppose that at the second stage of his study we asked the student not only to understand the history that he is studying, but also to understand the physical facts which influence history, making at this stage of the course a correlation between history and geography.

This would demand a power of comparison and associative thinking. Suppose that in the third stage we asked for a mastery of evidences upon which history is based; that is, a critical evaluation of the original sources. Suppose finally, at the last stage of historical discussion, we asked the student to make a critical comparison of the different authorities who have attempted to interpret a given period. Whether the historian would agree that this is the best order in which historical methods are to be taught or not, the example at least serves to call attention to the fact that there is a possible progression of intellectual demands within the course. The present tendency in history is for the most elementary student to be brought in contact with all of the possible modes of historical interpretation. Thus a teacher who has studied history through original sources, and who has seen the geographical correlation of history, assumes that all the different mental processes which are involved in the study of history can be aroused in the beginner. He starts out, therefore, to give the most complex reasoning about historical events to the elementary student. The elementary student becomes confused and is satisfied to get half of his lesson, never developing any standard of completeness; and the teacher is satisfied with a partial achievement on the part of the student because he recognizes that there are some aspects of the situation which are evidently too complicated for the student. The difficulty in this case is that the teacher has not analyzed the ability of the student, and has not developed in his own mind any notion of real progression which would make it possible to test the student's achievements in the first part of his course by ability to go on in the later parts of the work.

Science Courses lack Progression

The difficulty which has just been pointed out in history is also one of the conspicuous difficulties in the organization of science work in the schools. A student studies a little botany or a little physiography in the earlier part of his course. He is then transferred to a physics course or a course in general biology, and he begins all over again with very simple problems and very simple methods of scientific investigation. His first science course goes forward rapidly from simple problems to complex problems. His second science course begins as though nothing had ever been done to train him in scientific methods. Indeed, the organization of our schools is such that we frequently mix classes, putting in the second science course a number of students who have never had any of the earlier work, so that it is quite impossible in this second class to do anything except begin at the early rudiments of the science, while in the same course are students who have done several courses in related subjects. Thus, science courses are very frequently badly arranged or not arranged at all, and the student gets only a vague general impression of scientific method and its application to the problems in the particular field. In each of these sciences it is the subject matter which has been the dominant interest. The student has never been shown that there are different degrees of complexity in reasoning. He realizes very slowly, if at all, that the first stage of a science is to collect a few simple facts with a certain degree of accuracy. The second stage of science is to try and develop some sort of a general principle, utilizing in support of this general principle the observations which one has made. The third stage is verification; and so on. What is needed is a careful analysis of the mental processes which represent progress within the science. What we need is a list of all of the different kinds of mental activities that students are called upon

to go through in each of the sciences and in each of the humanities. We should realize, for example, that there is always some memory work, and that this memory work is essential to comparison and reason, which come later in the subject. Furthermore, the student should realize as well as the teacher that there is sequence from memory to reason.

Traditional Subjects Capable of Greater Progression

Other examples of the same fundamental requirements can be presented if one comes to a criticism of Latin and German, which were described a few minutes ago as having a sort of natural progressiveness. The student of Latin is undoubtedly a good deal confused by his transfer from Cæsar to Cicero. He recognizes Cicero as one of the higher courses in the high-school curriculum, but just why Cicero is more advanced than Cæsar is difficult to make clear to a student. Finally, when the transfer comes from Cicero to Virgil the student becomes aware of the added body of material which he gets in the principles of scansion, but it is not at all clear that the Latin itself requires any true progress on his part.

Suppose that the Latin teacher should make a radical distinction between the work in Cæsar and Cicero in some such terms as these: The class has been reading Cæsar. Now for some time, as we turn to Cicero, there will no longer be any requirement for detailed translation. It is assumed that the class can now read Latin in the original and can understand it without translation. Therefore in Cicero we shall call upon members of the class to read with expression the Latin text and to answer directly, in Latin, questions about the text. This would constitute a real step in advance, a real progressive demand upon the student. The student would now recognize that his

work in Cæsar is going to be tested by the demand that he use the original language itself.

Suppose that the same sort of requirement were imposed upon the student in German. We might say the simplest stage of German is that stage in which the student learns by translation. A later stage in German would be the stage in which the translation can be dropped. In setting forth this example one becomes immediately aware of the fact that the language teachers themselves have never agreed as to the relative difficulties of understanding a language through translation and through the use of spoken language itself without translation. Students of the direct method in German, for example, assume that oral expression in the language itself is the first stage. Translation for them would be a later study of a more complex type, since it would involve the comparison of German with English. On the other hand, Latin teachers have assumed that translation is a relatively simple mental process and that the mastery of Latin without translation would be a somewhat more complex form of mental activity. Perhaps, as pointed out in an earlier chapter, there are conditions under which each of these assumptions may be regarded as true. If we teach simple idiomatic phrases by the oral method, probably the use of the foreign language is somewhat simpler than translation. On the other hand, if we study a language, analytically getting at the notion of its structure before we try to make use of the language, perhaps translation is the simpler process. In either case the student should be required to progress.

Subject Matter less Important than Progression

The degree of complexity of the mental process would therefore depend upon the methods of procedure within the subject itself and upon the aims of instruction. It might not

be possible to say that a certain mental process taken out of the context is in itself more or less complex than some other mental process, but the teacher, and also the student, should be made aware of the fact that within each method of instruction there is the possibility of creating for the student progressive demands which shall carry him within that subject to more and more complex forms of mental life.

Progression within the subject is the only solution of the educational problem. It is to be feared that many teachers are satisfied with a wider range of information as the only demand imposed in the later stages of a given subject. They give more and more of the same sort of work in the later stages of a course without recognizing that more and more material of the same type and degree of difficulty will not constitute real educational progress. If the teachers in any given field would canvass their own subjects with a view to determining what is the demand at the later stages of a course, as distinguished from the demand at the earlier stages, we should have a series of discussions of the different school subjects that would be of first-class importance to the science of psychology as well as to the methodology of the subject itself.

Organizing a Study Program

There are certain external devices for securing economy and efficiency in the work of students which depend upon the general principle that organization of one's work is always more economical than unsystematic effort, however earnest. One finds that the ordinary high-school student has no regular plan of attack upon the subjects which he has to study. He goes home at night with four or five assignments, and the order in which he takes up these assignments is a matter of pure accident. Sometimes a student begins with the subject which he likes best; at

other times he begins with the subject that he knows will be most vigorously followed up in the recitations of the next day. Furthermore, the very fact that he has no regular order of procedure becomes itself a distraction, because as soon as he begins the study of one subject he will think of the other subjects which he might be taking up.

There are two ways of meeting these general difficulties. The first is for the student to have a regular program for his own work. Such a regular program as this is very difficult to maintain unless there is coöperation between the student and the teachers who have his assignments in charge. If the student sets aside a certain amount of time each day or a certain sequence of studies for his work, it is likely that the assignments will not balance in such a way as to make the most economical use of his time. Still, he will gain something by regularity of habits, even if his program of study is a purely individual affair. An interesting report has been made by W. C. Reavis,[1] who organized the high school of which he had charge on this plan of full individual programs for students. Not only were the study hours that occurred during the school itself assigned to various topics, but the students were induced also to fill up the hours which they spent at home with a regular program. The result of this organization of the students' work was a decided improvement in the quality and quantity of work carried by the students in that school.

Another general device which commends itself as having certain advantages over the organization of individual programs by the students is the organization of the general program of the school in such a way that the selection of the study which shall be treated as most important from day to day shall be determined by a plan arranged by the faculty. Thus the work of Monday should be organized in

[1] "The Importance of a Study-Program for High School Pupils," *School Review*, 1911, Vol. XIX, pp. 398–405.

all classes with a view to allowing science to have more time and attention from the students than any other subject. Tuesday might be devoted to mathematics; Wednesday to history; and so on through the week. This would give the whole school a certain definite arrangement of its work, and would prepare students to lay emphasis upon the different subjects in rotation. Such a plan as this would require some consultation among the members of the faculty as to the length of assignments, and would undoubtedly be advantageous from that point of view also. It would relieve the students of the necessity of determining each time just the order in which they ought to do their work. They would realize that they must prepare the assignment in the subject that has the right of way, whatever the fate of the other subjects.

Selecting Essentials

The principle of organization which has been illustrated in the last paragraph should reach not only to the general program of the students, but should reach into each individual subject. The material which is presented in the text-book and the class exercise is of course arranged with some deference to the sequence of ideas in the subject matter. There are undoubtedly in every lesson certain cardinal points which the teacher is able to bring out in the recitation, and ought to impress upon the students as of more significance than other points in the lesson. The difficulty is in training students to select these important points, and to realize that they are the essential elements of the lesson. Most students read with laborious minuteness everything set down in the assignment, and the lesson is not organized in their experience around central ideas. Their ideas consist merely in a train of sentences, all of which are evaluated as though they were of the same intellectual importance. To

correct this monotonous emphasis on everything, each class exercise should at some time in the recitation be summarized in a general way. Some student should be asked, either at the beginning or at the end of the lesson, to present the three or four major lines of discussion which are at the center of the assignment. Very frequently the assignment of the lesson can very advantageously be made in terms which shall point out these major items. In this way students will get into the habit of summarizing all bodies of material which come to them in the course of an hour. They will thus be prepared to take notes better, because they will learn how to select from the material which is given to them those items which constitute the key to each one of the phases of the discussion.

Elaborating a Theme

The necessary complement of the selection of the most important point is the cultivation of the ability to elaborate each point. Many students are able to give in very brief form a certain statement which is one of the important statements in the lesson, but they are utterly at a loss to take up that statement and illustrate it and elaborate it as the author of the textbook or the lecturer has elaborated the item. In our discussion of the methods of teaching English, attention was called to the fact that most students in American schools are quite unable to give any lengthy discussion of topics. One of the exercises which would be of great advantage in every subject is that which would grow out of the requirement that students take an important point in the lesson and write three or four pages on this point. Students would gain through such an exercise a much keener appreciation of the paragraphs in the textbook. Every author who has elaborated an idea in a textbook has had some reason for adding supplementary

and secondary illustrations to the main idea which he is discussing. These accessory ideas are just as necessary to the explanation of the main idea and to the development of connections with other ideas as is the bald statement of the principle itself. Students should learn how to connect ideas and illustrate them. They should be able to take up any major principle and find interesting points of connection between that major principle and other information, especially information collected in other courses. A good deal has been said in pedagogical literature about the importance of selecting the major idea, and certainly the comments which have been made along this line are all of them justified, but relatively little has been said about the necessity of elaborating major ideas as indicated in the foregoing sentences.

Training in Generalization

When students have gained some knowledge of a subject through a few exercises, it is very important that they should be trained in generalizing this knowledge. Emphasis was laid on this point in the chapter on science teaching and also in the chapter on formal discipline. It is in place at this point to indicate some of the methods of generalization which can advantageously be employed in the classroom and in the student's own mental procedure.

Anticipating the Future

In the first place, as suggested above, the student ought to try to look forward in the subject itself and anticipate the later problems which are to come up.

REVIEWS

/ Further than this, generalization of experience can be cultivated through frequent reviews. Indeed, the student and the teacher ought to realize that the function of a review is to crystallize earlier studies in more comprehensive forms than were possible while the subjects were being studied in detail. The student who gets an impression that a review just before an examination means a hasty running over of all of the material which has been covered in the course will not gain from the review the advantage which he ought to secure. He ought to realize that, having learned the subject in its details, he is now in a position to take a more general view of the whole subject. Principles too broad to be included in a single exercise ought now to be the subjects of his thought. After he has studied a certain period of history, for example, he ought to be able to characterize the whole of that period. This is a period during which military operations were the most significant public activities; this is a period during which the internal operations of the state were of more significance than any outside relations; this was a period during which the country prospered financially and commercially; and so on. None of these general statements would be significant to a student, if made at the beginning of the study, in any such degree as they ought to be after he has canvassed in detail the military or commercial enterprises which are summarized in his final review.

The general summary is also a great aid to the organization and presentation of the details if one wishes to elaborate these details later in answer to specific questions. Thus a review in science makes it possible to hold in mind, through the use of general formulas, the details of physics or zoölogy. One needs for general education not merely the detailed facts about motion and forces; he ought to

be able to grasp the general topics and to show that all of the details group together under the general principles of the distribution and conservation of energy. He ought to be able to describe in zoölogy the whole animal kingdom, pointing out the major characteristics of the different parts of the animal kingdom rather than the detailed structures of any particular species.

Broad general views of this type are the significant results of all specific courses when the student has really mastered the subject matter that he has been going over. Broad general views of this sort will also encourage students to realize that any subject which they study will be of significance to the broad-minded individual. The student who is going to go into business is not likely to care about the details of zoölogy or physics; but if he can feel, when he has completed a course, that he has secured nine or ten general principles in each of the sciences, he will be encouraged to regard these as permanent elements of his intellectual equipment, whereas now he commonly believes that he is at the end of the subject and is entirely content to forget all of the information which he has accumulated in these courses.

Generalization is the most important result of any study; and any course which does not permit its material to be generalized in a few salient principles that can be comprehended and carried away by the student is not organized in the form which justifies its retention.

Mental Hygiene

These practical suggestions for the organization of the course of study should be coupled with certain practical suggestions on mental hygiene. Every student should realize that there is a hygiene of mental operations exactly as there is a hygiene of physical operations. Indeed, in

many cases the two coincide exactly. Thus the student will find, if he watches carefully his own modes of study, that very frequently mental excitement is accompanied by a form of physical tension which is altogether unfavorable for his work. Anyone who has seen an eager student overworking in his efforts to get a lesson will realize that overwork consists in an abnormal tension of the muscles. Very frequently the facial muscles are so tense that the student is seen to be wearing himself out and expending his energy at an utterly unjustifiable rate. That student ought to be taught to relax. It is just as much a part of his intellectual training to learn to work without so much physical friction as it is to remember the ideas which he is reading. In fact, he will never be able to remember ideas so long as he works at that high physical tension.

Dangers of Overstimulation

Teachers very frequently transgress the requirements of mental hygiene when they develop in students an attitude which is entirely out of accord with their real needs. Thus a conscientious boy or girl is urged to study more because the teacher has fallen into the habit of assuming that boys and girls usually do not study as much as they ought to. The artificial devices adopted by such a teacher sometimes consist in an appeal to class loyalty or school loyalty. When the student, already overconscientious about his work, is thus urged to add to his efforts, he sits down to his task with his mind full of the necessity of not disgracing the class. He works at a high tension and under a form of distraction which is utterly irrational. Teachers ought to realize that there are many students who do not need to be urged to work. Some students ought to be told definitely that it makes no difference whether they get a certain lesson in great detail or not. Such students ought very

frequently to be encouraged to read over matter in a relatively superficial way and get the general principles, leaving the details to be worked out in the recitation itself. Once a habit of relaxed and deliberate study is cultivated, such a student will make progress because he needed only to reduce the distraction and tension in order to take a calm view of the subject which he is studying. There is quite as much danger of one type of student losing his perspective in a subject because he tries too hard and makes unnecessary motions, intellectual and physical, as there is of another type of student failing because he does not study enough.

Dangers of Distraction

Of course there are and always will be students who need to be encouraged to work. The teacher must learn to discriminate. The people who do not work enough are either constitutionally phlegmatic or they are distracted by outside engagements. Outside engagements constitute a much more common source of distraction in the school than do constitutional limitations of any sort. A recent study[1] which has been made of this matter goes to show with perfect definiteness that students who have numerous other engagements fail in their school work just because of these outside engagements. A student ought to realize and the parents of students ought to realize that a certain amount of energy is at hand during the school period. It is entirely legitimate for the student and his family to decide that this energy ought to be expended on activities other than those covered by the school curriculum. For example, it is undoubtedly legitimate for the student to take a course in art or music; but if this work outside of the regular curriculum is taken by the student, there ought to be such a

[1] I. King, The High-school Age, Chaps. x and xi. The Bobbs-Merrill Company, 1914.

readjustment of the school program that the outside work will not simply be added to the demand which is made for the regular work. The fundamental principle of physical and mental hygiene is the principle of distribution of energy. Overtaxing of energy is illegitimate and disadvantageous from every point of view. Why not allow the student to go more slowly through his course of study in the school, in order that he may cultivate certain other lines of activity which are good and often more advantageous to the individual than are the school courses? This would mean that students would move through the high school at various different rates; and there ought to be no social or intellectual stigma attaching to this movement through the high-school course at a rate which is determined by the outside activities of the student.

Adjusting Study to Outside Engagements

One remembers the plan which is in regular use in the English universities of distinguishing between students who are aiming at high intellectual honors and those who are merely passing in their courses and are using their energies for outside social activities. Whether this is a plan that can be adopted in a democracy or not, it is certainly rational in the sense that it does not assume that all students are going to put forth in study the same kind or degree of energy. Probably we should not want to make the distinction in this country on the basis of the English university plan, but we certainly may with propriety relate the work done inside the school and the work which a student is doing outside of school hours. If for some reason or other the student is going to be engaged in outside activities three days in the week, he certainly ought to make this a part of his general program. If he can afford to give four or five days to these outside engagements, he ought

to recognize such engagements as part of his legitimate program of intellectual and physical effort.

What has been said with regard to outside activities ought to cover also those activities which are organized by the school as social and athletic undertakings. There ought to be absolutely no prejudice against recognizing this work and making it a part of the legitimate program of the students. It is a fundamental mistake to believe that the immature student can regulate without advice and supervision the amount of energy which he can properly devote to these activities outside of the regular course. If we are not prepared to put such engagements on the same footing as class work, we certainly must realize their relation to the work which is credited toward graduation ; and this relation ought to be adjusted in a rational way. The amount of energy which students have available is enormous. This fact is attested by their numerous organizations and numerous lines of activities not immediately connected with the school program. If one attempted to get the whole of this energy for school courses, he would find himself obstructed by the social temper of the school and of society at large. Society regards irregular social and recreative activities as important for high-school students. How far these activities may legitimately absorb the student's energy is a difficult problem for both society and for the school to solve, but it is certainly time that the problem received grave attention. Appeals must be made to the students themselves in terms of scientific self-management to distribute their energy with an economical and clear recognition of the fact that the energy which is available at any given time in life is limited.

Such discussions as these lead us to the whole problem of secondary organization and the problems characteristic of the adolescent student. In the next chapter we shall have an opportunity to summarize briefly the general facts which are now available on these subjects. In the meantime

the conclusion of the present discussion is that there ought to be a definite, conscious recognition on the part of students of the necessity of studying mental hygiene. Mental hygiene is quite as important as hygiene of buildings and of the physical system. Mental hygiene involves a study of individual differences; it involves a study of human energy and its distribution; it involves the recognition of the fact that the course of study is only one factor in an education, but a factor which must be safeguarded by a clear recognition of the fact that the course of study cannot be pursued unless the intellectual and physical conditions under which it is presented are favorable to this pursuit.

Excellent Students require the Maximum of Attention

Finally, it should be emphasized once more that all this discussion about how to study and how to organize intellectual material and distribute energy is more important for the strong student than for the weak or mediocre student. We commonly recognize the necessity of helping the student who is failing, though we usually do this rescue work badly because we have not given due attention to good habits of study. It is time for us to learn how to guide those who do excellent work quite as much as those who do a low grade of work.

CHAPTER XIX

GENERAL PROBLEMS OF SECONDARY EDUCATION

General Social and Hygienic Problems

Casual reference has been made in earlier chapters to general psychological conditions which govern all of the activities of school life. A relation of friendly coöperation between teacher and students is one such general condition. Grave consequences for the intellectual life of students follow failure to establish friendly relations. Furthermore, favorable hygienic conditions must be provided for school work. The physical conditions which are necessary for healthy functioning of the nervous system must be secured if there is to be vigorous and productive mental work.

Special Characteristics of the High School

It is not the purpose of this chapter, however, to enter into a discussion of these general facts of school hygiene and mental hygiene. We shall discuss what might be called the problem of social hygiene. There are certain unique characteristics of the high school which determine the social and mental atmosphere of this institution. These unique characteristics of the high school affect the intellectual work of the students in such a degree that we shall be able to understand the work of each department only by defining the place of this department in the general scheme. We shall accordingly take up in this final chapter such general characteristics of the high school as influence the activities of the students.

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General Social Changes

A generation ago the high school stood apart from the common schools as an institution to be attended by the select. One reads the history of American secondary schools with a clear recognition of the fact that fifty years ago the ordinary family did not expect to send its boys and girls through secondary schools. It was not until the rapid development of the secondary schools in the eighties and subsequent decades that the general social attitude toward the high school came to be something like the attitude toward the elementary school. In fact, one can trace a very interesting evolution of the relations between the two schools. In the older sections of the country there was a vigorous effort made to extend the elementary-school period so that every child might have as much education in the common school as possible. We find, therefore, that in New England there was an extension of the common school to include the ninth year of school life. Even to-day one can find in many of the cities of New England a nine-year elementary school. This nine-year elementary school is the expression of a high economic and social development. Since the common people did not expect to send their children to the high school, it was natural that they should seek for these children as full an opportunity of elementary-school life as possible. The difficulty with the nine-year elementary school was that it did not provide in the upper grades for any training other than that which had been traditional in the lower grades. The ninth grade offered nothing but mere repetitions and timid extensions of the work done in the lower grades.

The High School as Part of the Common School

In the newer sections of the country there is absolutely no disposition at the present time to extend the elementary school through the ninth year. If one visits the elementary schools of the Middle States he finds, indeed, that there is great eagerness on the part of communities to provide as full an educational opportunity as possible for the young people of these communities, but it never occurs to a community in the Middle West that it is desirable to extend the elementary school. The fact is that the high school is the natural place for most of the young people in the community to continue their education, and access to the high school is made so easy that there is no reason for an extension of the elementary school. There probably will never be a repetition in newer parts of the country of the New England phenomenon of an added year of elementary education.

The same general movement appears in the South, where there is no disposition to extend the seven-year elementary school which resulted from the relatively unfavorable economic conditions that limited the development of public common schools. The seven-year school appeared merely because it was not possible, on account of economic conditions, to reach the full organization of New England or of the middle states in the North. But this seven-year elementary school has served so well the purposes of education, and in the meantime there has been so vigorous a development of secondary education in the more progressive communities, that there is a consensus of intelligent opinion against extending the seven-year school into an eight-year school.

We have, accordingly, in this country at the present time three types of elementary schools, the seven-year school, the eight-year school, and the nine-year school.[1] All of these

[1] E. C. Brooks, "Seven, Eight, and Nine Years in the Elementary School," *Elementary School Teacher*, 1913, Vol. XIV, pp. 20–28, 82–92.

will be understood when one recognizes the fact that the present-day movement is in the direction not of the elaboration and extension of elementary education, but rather in the direction of amalgamation of the elementary school with the high school in such a way that the latter institution shall become a part of the common-school system.

This new attitude toward public education is of the highest advantage because it opens the way for any readjustment which can be justified by scientific studies of education. So long as there was a breach between the two schools the problem of readjustment was complicated by institutional barriers. With these barriers removed, there is no reason why considerations relating to intellectual and physical development should not come into the foreground. The social movement which has opened the high school to all the children is therefore a movement toward the best educational organizations.

Effect of Rapid Increase in Attendance

The clearest evidences which appear within the high school itself of the adoption of this institution into the common-school scheme of education appears in the rapid growth of the high schools. The facts which have frequently been summarized in the reports of the Commissioner of Education show that during the decade immediately preceding 1900–1901 the number of secondary schools, including both private and public, increased nearly 100 per cent, and the number of students increased in a somewhat higher ratio. In the decade from 1900–1901 to 1910–1911 the number of schools increased from 8210 to 12,213, and the number of students increased from 649,951 to 1,115,326. At the end of the year 1911–1912 there were 13,268 schools and 1,246,827 students. This great increase in the number of students attending high schools indicates that the social

movement in the direction of a democratic institution is very strong. Such an influx of students brings into the high school every possible kind of interest. It is not merely the students who are going to enter the professions who now take a secondary course. Many students enter the high school with a definite knowledge that they are going into business or into the other nonprofessional activities of society. When a variety of interests begins to assert itself in the student body, consequences are sure to appear in the organization of the course of study and in the intellectual life of the school. It is quite impossible to think of a rigid required course under the social conditions represented by this increase in the high-school population. It is quite impossible to think of a policy of elimination of students on a basis such as was laid down in the earlier days of the secondary school.

We shall not attempt to describe in any detail the psychological consequences of this movement toward democracy. Certain disadvantages doubtless appear with this rapid expansion. The individual student is distracted by the bewildering variety of social relations. The tendency to pay attention to people rather than to studies is often remarked as one of the dangers of the present-day high school. On the other hand, the constant emphasis on social and practical relations has a broadening influence which no subject of instruction taken by itself can supply. The psychological atmosphere is broad and free, and the study which goes on in the school and at home is radically affected by this new and stimulating social environment.

A Wider Intellectual View Characteristic of the Age

A further change in the psychological atmosphere is to be explained by calling attention to the productive scholarship and wider national life which have in recent years given

to the high schools a new body of material of instruction. The rapid enlargements of modern science and the extension of commercial relations are so obvious that a mere reference to these without any effort at quantitative evaluation suggests one of the major causes for the vigorous intellectual life of the age. The boy who went to high school in 1890 had no such interest in European civilization as does the boy who twenty-five years later enters upon his high-school course. The present-day boy may be interested in Europe because he expects to develop commercial relations with some country in Europe or he may be interested for the general reasons which prompt all of us to consider the place of the United States in the politics of the world; but it is certain, whatever the motive, that the high-school boy of to-day knows more about European affairs than did his father when his father went to the high school. In the same way natural science has come to be one of the general possessions of society. A generation ago natural science was the field of the specialist, and the applications of scientific principles in the industrial and mechanical world were comparatively few. To-day all sorts of complex mechanical devices are familiar facts in the home and in community life. The high-school student must be introduced to all of the underlying principles which govern these industrial changes. Indeed, so urgent has come to be the need for knowledge of mechanical principles that some of this material has been introduced into the elementary schools as well as into the high schools.

Agricultural High Schools

In its attempts to deal with all of the new problems that are arising, the modern high school is boldly trying the most radical experiments. One finds that a school has arisen in rural communities known as the agricultural high school.

This agricultural high school is attempting to develop a body of knowledge which shall be appropriate to the age and maturity of the students and shall at the same time serve the definite social end of training members of the community to remain in the rural districts and carry on their life work in agriculture.

Technical Schools

Parallel with this agricultural high school there have grown up in the cities technical education and commercial education. These various types of training have asserted themselves with sufficient vigor to receive the enthusiastic support of the community. It costs more to build and equip a technical high school, and the cost of maintenance for such a school is much higher, than that of an ordinary school. But the communities in which these schools have been established have usually supported them with even greater willingness than they have manifested in providing for the ordinary school.

Readjustment of Standards

Agricultural and technical high schools have not hesitated to abandon most of the standards which were familiar to the old-fashioned classical high school. This abandonment of familiar standards has led to criticism and counter criticism. Colleges and academic people in general have questioned the propriety of many of the courses which are offered in these technical schools, on the ground that they are lacking in power to train the student. The technical high schools have retorted by criticizing the colleges and the classical courses as thoroughly formal and unproductive. We have, therefore, the extraordinary sight, at the present time, of a great social movement which is pushing in the

direction of the enlargement of secondary education while the academic world seems to draw back and hesitate, rejecting many of the experiments in secondary education and exhibiting skepticism about the movement as a whole.

Perhaps one of the most striking evidences of the complexity of the present situation is the long list of agencies at work trying to standardize the courses of education in secondary schools. Since the Committee of Ten completed its work numerous efforts have been made to enlarge in some form upon the work of that committee. There can be no doubt at all that the bringing together of material by the Committee of Ten on the course of study promoted very greatly the organization of secondary schools. That committee did its work just at the beginning of the epoch of rapid expansion, and its influence can hardly be overestimated. But the time is long since past when a well-organized high school can be satisfied with the recommendations made at that time. At first thought, therefore, it has seemed to some desirable to recommend another such committee. A study of the recent history of the high school, however, discourages so simple a device.

In the first place, there is very little possibility at the present time of devising one formula which will include all parts of the country. The Middle West has a type of high school which no one born and bred east of the Allegheny Mountains can comprehend. The committee which tries to put the high schools of Cincinnati and St. Louis into the same general scheme with the high schools of Hartford and Worcester finds that it is dealing with incommensurable quantities. The tendency, therefore, has been to carry on standardizing through a number of distinct, local agencies.

In the second place, development of courses and plans of instruction has gone forward at such a rapid rate that standardization in the ordinary sense of definition before the course is given is no longer possible. The experience

of the North Central Association of Colleges and Secondary Schools in this respect is very striking. The work of numerous departmental committees became so rapidly antiquated that even the effort to keep up these detailed reports has lapsed.

Excessive Emphasis of Quantitative Standards

In a period of rapid readjustment the tendency of human nature to grasp at the one easy device of quantitative evaluation has unfortunately dominated thought and action. We have a quantitative standard all over the United States. It is a fiction of the most ludicrous transparency, but it seems to be satisfying to some who know little about the real conditions, especially to those who solemnly sit in judgment on those graduates of high schools who wish to go to college.

Number of Required Units has rapidly increased

Let us consider briefly some of the facts regarding our present-day quantitative standard. When the definition of a high school was given by the Committee of Ten, it was assumed that the student's weekly program might consist of sixteen periods of work, with a possibility of extension in exceptional cases up to twenty. Nowhere in the report of the Committee of Ten are more than twenty mentioned; and wherever twenty periods are mentioned it is evident that the Committee regards this number as an extreme maximum. If a student carries sixteen hours of work a week, as the Committee of Ten evidently intended that he should, he would complete at the end of a four-year course twelve or thirteen units of work. Or else a unit would consist of four periods a week. This was a very familiar kind of requirement when the Committee of Ten was doing

its work. To-day no secondary school could maintain itself as a first-class high school if it gave to its students twelve units of work in a four-year high-school course. Furthermore, all of the standardizing agencies discourage four periods. Fourteen is the absolute minimum to which the school may fall, and sixteen is the common requirement for graduation. The ordinary student in an American high school expects, therefore, to take at least four units of work each year. In order to be quite safe in completing four units a year, he is likely to take five. In many cases the school is so organized that during the years when the student is taking work which is, for the most part, required, he will regularly find himself required to take more than four units of work. In some cases the excess beyond four units is dropped before the end of the year, and in some cases the student fails in one or more of his courses, but readjusts and achieves graduation at the end of the fourth year because of the excess units which he elects at some time during his course. Furthermore, there are many students who are anxious to get off the major part of their requirements in the early years of the course, so that they may have a light election of studies during the last year. Finally, many students complete the high-school course in less than four years by taking five units.

Motives for Increase in Number of Units

The agencies which have been at work increasing the number of units demanded of high-school students have been prompted in part by the desire to include in a given student's training a large number of subjects. As the required classical curriculum of earlier days has been forced to give way before the newer subjects, the simplest device which suggested itself was to add the new subjects as extras. English was once an extra in some schools. To-day

there is a fringe of noncredit extras which will presently be adopted "for credit."

The second motive which has been strong in pushing up the number of courses required for graduation is the desire to secure a greater quantity of intellectual work from students. Every generation of teachers has felt that students do not do all the work of which they are capable. Again, it seems natural to assume that the simplest device is to require more courses. It would be possible to require more study within the limits of existing courses, but such internal requirements can be enforced only when instructors have the highest qualifications of initiative and skill. The external quantitative standard is therefore accepted while internal improvement is left to the vicissitudes of chance.

Emphasis on Quantity has become Formal

The emphasis on quantity defeats its own purposes. Let us try, for example, to estimate the requirements which can be imposed on a class studying algebra in a present-day high school. This class is made up of members all of whom are taking three other units and some of whom are taking four other units. The class also contains members of the athletic teams and social organizations. The class is made up in large measure of young people who do not intend to use algebra for professional purposes. Without commenting at this time on the desirability of their taking algebra, the fact is that they are together in this class, and the business of the teacher is to see to it that something productive comes out of the undertaking. Can the teacher require as much work of such a class as was required twenty years ago when a class in algebra was made up of a restricted membership, in which most of the students were pursuing only two other subjects? Most of the members of the earlier class were also free from outside

distractions of any engrossing type. The answer is perfectly clear. The quantity of work which is now undertaken in any particular course differs radically from the quantity which could be required before the quantitative standards were pushed up to their present level.

Standardization extremely Difficult

If we turn from the quantitative definition to discover what degree of readjustment or redefinition ought to be required, we find that we are in the midst of uncertainty and the sharpest disagreements. There is no subject of instruction in the high school which has an accepted method. There are some teachers of the classics, for example, who lay great stress upon grammatical constructions; there are others who openly express their dissatisfaction with the grammatical method, and are carrying on courses which lay very little emphasis on grammar. College teachers of the classics complain bitterly because students come to them without knowledge of the fundamentals, as they call them, of the Latin language. One might go on through the list, pointing out the discrepancies in qualitative standards in different high schools. Various associations have attempted to define these subjects in the high school, with the result that elaborate committee reports are at hand, differing from each other so radically that it is evident that no one is prepared to allow anyone else to define for him the subject matter of a high-school course.

Elimination as a Spur to Effort disappearing

This vagueness of standards is exaggerated by a change in the social attitude with regard to school standards in general. The time was when every higher institution prided itself on the number of students it eliminated. One still

finds individual instructors and institutions which adopt the standard of elimination as the expression of the highest academic efficiency. One finds an institution, for example, which eliminates at Christmas time fifteen to thirty-five per cent of the students who were admitted in the autumn. This elimination is supposed to be justified, on the ground that during the first term the students have been tried out. There is, however, a growing conviction that wholesale elimination is a mark of inefficiency. If this growing conviction could express itself, it would be something like this: No institution has the right to admit in the autumn students who are likely to be eliminated by Christmas time. Whenever an institution makes a wholesale elimination at the end of the first term, this elimination is the clearest possible evidence that the institution has not succeeded in establishing proper relations with the schools below. If students are not qualified to go on with the work of a given institution or a given class, that fact ought to be known at the beginning of the course. It is the business of the higher institution to make its purposes clear enough to the lower institutions so that there shall not be wholesale elimination.

Distribution taking the Place of Elimination

Furthermore, elimination is a very doubtful method of treating young people in a democratic community. Would it not be better to find means of requiring of these young people satisfactory work? Would it not be better to redistribute them in some fashion or other so that they shall ultimately find courses which they can take with profit and in which they can do a satisfactory grade of work? We have such a school system as that of Newton, Massachusetts, for example, deliberately putting into secondary courses young people who have not completed the work of the elementary school. We find that the members of this

transferred class are successful in a very high degree in doing more advanced work. We find that society in general is asking, not that boys and girls be eliminated, but that the course of study be so modified that something can be given to each boy and girl which will be profitable for his intellectual and social growth. This standardizing of courses by the demands of the communities, rather than by eliminating members of the community because they do not conform to the demands of the curriculum, is an entirely new development in the educational world.

Contrast between German and American Methods

One becomes very conscious of the fact that we are working out new standards and new methods of adjustment in America when he contrasts American secondary schools with the secondary schools of European countries. The German *Gymnasium* maintains its standards very much as the high school of a generation ago maintained its standards. If a student secures admission to a *Gymnasium* and does not conform to the requirements which are set up in that institution, he is instantly eliminated. In fact, in Germany the pressure is so great for admission to this institution, and the conditions are so crowded in the professions and other social callings to which a higher education leads, that the whole social system favors elimination of individuals who seem to lack in any degree the ability to carry on the work of the higher schools. The result is that the German *Gymnasium* is a highly conservative institution. It changes its standards and its course of study very little. It is in no sense a popular institution, and it is in no sense an institution which tries to fit its course of study to general social demands. The other secondary schools of Germany are very much more liberal in the type of course which they administer, but they have been so influenced by the *Gymnasium*

that their method of maintaining standards is the method which was formerly familiar in the American high school. Indeed, one finds as he considers the German school situation that the principle of elimination goes one step farther. The *Volksschule*, or common school of Germany, is itself an instrument of elimination. Anyone who goes into this common school is cut off from the possibility of a higher education and from admission to any one of the professional careers. The system of education in Germany is a dual system. One group of children, including over 90 per cent of the population, is expected to complete the work of eight years of elementary education and then to go into the lower, general activities of society. The other group of children, selected because of their economic conditions and social connections, is permitted to enjoy the opportunities of a secondary education; but, as indicated above, this group is so large and the desire to reduce the group is so intense that elimination goes on in the higher schools, thus adding within the secondary school another type of selection to the fundamental selection which prevents many from beginning a secondary education.

German Standard Undemocratic

The German system makes it possible to set up and maintain a definite and relatively simple standard. It is the arbitrary standard of the instructor who is interested in a special subject in which he is a specialist. He requires of the students under him a certain degree of mastery of the subject. There is very little concession to the individual. There is no elective opportunity to adjust courses to individual capacities and tastes. The product of such a rigid system as this is much more uniform than the product of an American secondary school, and it is much easier to understand the excellencies of such a uniform product than it is to comprehend the virtues of our American democratic

system. We sometimes find ourselves criticizing the miscellaneous character of the American high-school course and commending the rigid uniformity of the German course. When one considers the historical background of our own American course, however, he sees how utterly impossible it would be for us to go back to the German ideal of secondary education. We must master the difficult and complex problem of a democratic social standard even if we have to suffer for a period while we are working out the uncertainties of this type of organization.

English Examination Method

In England we find another type of more or less rigid requirement which contrasts with the standards of American schools. The method of standardizing English schools is the examination method. One finds in England a whole series of corporations and institutions devoting themselves to the examining of students who have reached various stages of maturity in the elementary and secondary schools. There is a corporation at Oxford, for example, and one in the municipal universities of central England which will supply to any institution a set of examination papers on almost every conceivable topic of instruction. Students write the papers, and these papers are sent to Oxford to be examined by official examiners. The successful passing of this or some similar examination is the key which unlocks for the student the higher opportunity of education. If the student is a member of a family of wealth he may try these examinations with deliberation, and he may make as many efforts as his own patience and the natural limitations of his increasing age will permit. He can drift along through the school system by taking these examinations, therefore, at a slow rate in the hope of ultimately reaching some institution where he will get the kind of training which will give him

admission to one of the professions. The poor boy, on the other hand, must pass these examinations, and must pass them well, in order to gain admission to the higher institution. If he passes them well, he will get his fee paid. There is no free secondary school to which he may apply. The school is free to him as an individual because he gets a scholarship which pays his fee, but there is no disposition in any of the English secondary schools to open the door to all comers as does our American high school.

Criticism of the Examination Method

This effort to standardize English students suffers in many respects. The examinations given by the various corporations are criticized even in England as very unequal in their severity. One of the leading systems of examinations is commonly spoken of as too easy to give a definite standard to the students who are subjected to its tests. All examinations given by those who have not been in intimate contact with the student's instruction are arbitrary. Furthermore, there is no certainty that the examination will pick out the best students for scholarship awards. The boy or girl who is fluent and able to pass an examination gets ready recognition, whereas the slower and more deliberate boy has difficulty in securing access to the higher school. Experience shows also that the accidents which frequently prevent a student from showing his real ability in a single crucial test constitute a fatal objection to the examination system. Finally, if one is to judge of the success of the English system by the demands which democratic leaders are setting up all over England for freer access to the higher institutions, it is evident that there, as in this country, the movement in the direction of a more democratic secondary education is sure to overthrow arbitrary and external standards.

Standards for Girls

In general, it may be pointed out that both in Germany and in England the admission of girls to secondary education is relatively less common than the admission of boys. Indeed, one may say that Germany has only the beginnings of a system of secondary schools for its women; and in England the opportunities for girls are also limited.

Natural, Democratic Standards in American Schools

One turns from these Old World efforts to standardize secondary education to American high schools, with a realization that whatever is done here to standardize schools must be done in an entirely different spirit. We cannot tolerate a scheme which is primarily one of elimination. Society has opened the high school to all American youths. These schools are now a part of the general school system of the country. In population and variety of interests these schools represent a social movement of a magnitude not equaled in any other country. Our adjustment of the situation must grow out of a careful consideration of students' interests and of the interests of related institutions. We must study the students. We must know something about the changes which go on in the adolescent mind. We must understand the relation of various subjects of instruction to individual changes, and we must be prepared to group the subjects of instruction in such a way that the purposes of society shall be served and a group of young people shall be trained for the highly diversified activities of social life. No theoretical or traditional standard will serve the purposes of present-day secondary education. It cannot be said that the high school must give such and such a course merely because that course has been

thought to be of value in the past. It cannot be said that anyone can set up a theoretical standard which gets its justification from a study of some subject by a specialist in that subject. The specialist must study also the relation of his subject to the students and to the demands of society.

The high schools realize fully the new strength and independence which they have acquired in their purpose to be of service to the community at large. They are no longer interested in the arbitrary comments of college boards of admission on what ought to be the standard of a high school. They are not interested, indeed, in trying to send their products to those institutions which assume that the high school is a subservient and dependent organization. The high school is in a very real sense of the word a part of the common-school system; and if colleges are not prepared to connect themselves in turn with the common-school system of the country, the result will be the worse for the colleges and not for the common-school system. It is indeed proper that all members of the educational body should join in the discussion of educational standards; but he who would prescribe the program for a high school in these days of general, democratic education of all the young people of the country must be prepared to give for his prescription a better justification than either tradition or his own opinion. He must be prepared to say that the subject which he is advocating and the mode of administering that subject which he would defend is of genuine service in promoting intellectual and social development of young people of the age of high-school students.

The intellectual atmosphere of the high school is seen, in the light of the foregoing discussions, to be an atmosphere of stimulating democratic experimentation. Such crudities and uncertainties as are manifest are symptoms of an inadequate mastery of a new and complicated situation. But the work of both students and teachers is going on under

conditions which promise much for the enlargement of the influence of this institution. Furthermore, as has been repeatedly pointed out, the high school is now in a position to make the radical changes which a careful scientific study of its problems dictates as desirable. The restrictions which limited the work of the high schools in the past are largely broken down, or at least so far weakened that there are no serious barriers in the way of needed reorganization.

Changes Characteristic of Adolescence

Many of the considerations which must guide in this reorganization have been fully discussed in the foregoing pages. It remains to make reference to some of the general facts which did not properly appear in earlier discussions.

First, there are marked external changes of physical development. The growth of adolescents may be described briefly by saying that girls develop from eleven to thirteen years of age, whereas boys show a similar growth about two years later. This growth consists in a general enlargement of the skeleton and a change in the relation of the different parts of the body. For example, the face enlarges, but the skull does not change very much in its capacity. The trunk grows longer, while the legs show relatively less growth. There is an enlargement of the heart, but less change in the arteries and veins. There is a rapid growth in the sexual organs. This unequal growth of the organs produces certain radical changes in the internal organization, and these in turn are accompanied by a change in the functional life of the individual. The blood pressure increases because of the change of relation between the heart and blood vessels, and this higher blood pressure brings about marked changes in the energy of the individual. Often there are changes in the appetite. Food which the child enjoyed now becomes distasteful.

These physical changes undoubtedly are the sources of some of the psychological changes which appear at the same time. For example, the adolescent youth is very likely to be moody in his temperament. He is sometimes elated to the point of exultation; at other times he is depressed and plunged into the deepest melancholia. Girls at this period show marked tendencies toward hysteria. These emotional conditions arise from the fact that the nervous system is experiencing the changes which follow the increase in blood pressure to which reference has already been made. Again, investigation has emphasized the fact that the period of adolescence is the period of religious awakening. There are more conversions in the adolescent period than at any other period in life, and in this connection attention is drawn to the fact that the ceremonials of primitive peoples always emphasize the adolescent period as the period for initiation into religious orders and into religious knowledge. The type of reading matter which an adolescent youth enjoys is different from that which was enjoyed by the child of younger age. There is a tendency toward romanticism and sentimentalism. There is undoubtedly a larger interest in the opposite sex. The interests of boys begin to turn toward the occupations upon which they expect to enter in later life, and the girls become aware of the impending duties of adult life. There is, therefore, a natural emphasis upon considerations of the type that look forward into adult life rather than backward into childhood.

Hall's Discussion of Adolescence

The facts thus briefly reviewed are sufficiently impressive to receive all the consideration which has of late been given to them. The educational world owes a large debt to G. Stanley Hall for his work on adolescence. It is little wonder that a pioneer in the field should be overenthusiastic

about his finding. Hall becomes intemperately speculative in his writings. He marks off adolescence from the rest of life with all the verbal and theoretical devices at the command of a fertile mind. Adolescence is a second childhood; it repeats certain crucial stages in the evolution of the race. It is to be thought of as the period of the wildest emotional upheavals. It is unique in its psychical processes and crucial for all later development. The period of elementary education sinks into unimportance awaiting this one final period of intellectual readjustment.

Whatever there may be of exaggeration in these fanciful analyses, studies of adolescence have performed the one great service of drawing attention to the fact that mental life has a certain periodicity. After the first intoxication of this discovery we may settle down to a careful evaluation of the facts. The changes which gradually accumulate during an earlier period of child life are consummated in adolescence in such a way that a marked qualitative and quantitative change takes place in mental character. Undoubtedly the clearest conception can be gained of the adolescent period by giving attention to the way in which this period grows out of the preceding periods.

Intellectual Development in the Elementary School

We turn, accordingly, to a brief survey of the changes which have been going on intellectually during the elementary-school period. The little child just entering school has social interests quite as strong as those of the adolescent, but these social interests of little children are of a different type from those which appear in the later stage in which the high school is interested. When a child goes into the primary grades he is very much interested in trying to do everything that older people about him do. He wants to

read not because he has any appreciation of the value of this art or any desire to accumulate information; he merely wants to be admitted to what he recognizes as one of society's modes of procedure. One hears parents giving accounts of the early exhibitions of this desire to be admitted to society in such form as this: A little boy of four years of age is found holding the newspaper patiently before himself as though he were reading. When inquiries are instituted to find out what motive he has in doing this, it is discovered that he believes it to be the proper thing for all men to hold newspapers before their faces because he has seen his father engaged in this absorbing performance. The strenuous efforts that are made by little children to use pencil and paper in writing are of exactly the same type. Such efforts show a desire to initiate one's self into society rather than an impulse to accomplish anything for which there is a real external motive. The type of social life here exhibited is not purposeful; it is imitative in character. Little girls like to play with dolls for this reason, and boys like to imitate the carpenter and other workmen whom they see about them. All of these cases illustrate the desire of the child to become a part of the social organism which he observes. He has in this early stage no standards of perfection, and he suffers no embarrassment from his misuse of the tools which he sees others using. It may be said that he is not aware of the fact that society is critical of anything that he does; he therefore works with the tools of society without the slightest embarrassment.

Developing Social Consciousness

Such an early type of social interest must be contrasted with the type of social interest which appears during the period of adolescence. Here again the youth is interested in the doings of society, but he has now acquired through

experience a different attitude toward society. He realizes that people about him who work with tools are all of them working at a much higher degree of perfection than he is able to exhibit. His interests are therefore not merely those of imitative effort; his interests are those of social excellence. He wishes to do the thing as well as someone else does it. He is becoming aware of the standards of society, and these are embarrassing to such an extent that the adolescent age is a period of extraordinary clumsiness. It would be out of keeping with the facts to say that the adolescent period is any more a social period than is the period of early childhood, but there is a new qualitative aspect in the social ambition of the adolescent youth which marks it off from the earlier period of mere imitation.

Psychological Characteristics of Intermediate Grades

Furthermore, there lies between the earlier social interest exhibited by the child in the primary grades and the later period of adolescence an intermediate period during which the interests of the child are not primarily social. If one watches the development of the children in the elementary school he finds that after a period of compliance with all sorts of social demands during the first three years of school life little children begin to exhibit a type of independence which they do not exhibit in the primary grades. After the child has learned to read, for example, in the first two or three grades, he begins to be independent of the school's attitude toward reading, and he begins to want to read something for himself. The type of material which he selects becomes more independent in character, and he very frequently seems to be out of joint with the school's requirements. It can be shown that the fourth and fifth grades are centers of the greatest incoördination in school

work. Children fail of promotion and drop out of school in larger percentage than at other points in the school system. In matters of discipline the fourth-grade or fifth-grade boy is likely to be wholly unsocial in his attitudes. During the early years he has been obedient without very much question. No one ever finds a second-grade or third-grade child insubordinate to the school's discipline, but in the intermediate grades the child begins to realize his independence of society by trying experiments to see what will happen if he does not comply with the rules of the classroom.

This intermediate period is also one of great interest in the material things of the world. So far as the intermediate boy is interested in society, it is chiefly because society is producing something in the industries. He wants to get out of school so that he may go into the shop or go into business. He has a large interest in the doings of men, especially in their actual productive work in the external world. He has learned in the lower grades something of society's methods, and he now begins to apply these methods to the material things about him. Out of all this independent experimenting comes a vivid realization of one's own personality and of the standards of society and the physical world.

The Adolescent Period

The adolescent period which follows this intermediate period can be understood only by realizing that the adolescent period is immediately preceded by a period during which the child cultivates a very high degree of personal and social independence, and at the same time comes to recognize the existence and the importance for him of a physical and social environment. With all of this preliminary training the adolescent youth also has impressed upon him the lesson that he must very shortly take a part in the adult activities of society. Is it any wonder that he is afraid

and clumsy? Is it surprising that he becomes moody and introspective? Evidently the adolescent period is a consummation of the intellectual development through which the child has been passing for long years.

The productive view of the adolescent period is therefore not that view which emphasizes the break between earlier education and adolescent training, but a view which finds the foundations of adolescent character in the changes passed through during elementary training.

Fourteen or fifteen years of age — the period at which the elementary school is completed by the ordinary child — is a period when the changes of adolescence may be regarded as so far completed that the individual child already realizes his own personality in terms of the newer adult life into which he is to enter. The necessity of recognizing the onset of the adolescent period somewhat earlier is coming to be very obvious to careful students of educational organization. We have seen in earlier paragraphs that the whole social situation within the high school has been so modified in recent years that the school is rapidly freeing itself from the traditional difficulties arising from a breach between the elementary and high schools. Scientific studies point most emphatically to the necessity of explicitly recognizing the needs of adolescence at a period earlier than fourteen years of age. It is true that children of fourteen and fifteen years of age are consciously assuming an entirely new attitude toward society. It is equally true that these children ought to have some preparation in the years immediately preceding fourteen and fifteen for the new type of work and the new type of thought which they are to take up.

Anticipating Adolescent Needs

For example, in the matter of industrial education we are beginning to be aware of the fact that a boy who is fourteen years of age needs to be prepared, in a higher degree than he now is, to consider intelligently matters of vocation. We are keenly aware of the fact that boys between the age of fourteen and sixteen are not provided for in our educational system. Consequently we are making frantic, belated, and ill-coördinated efforts to provide for these young people some sort of industrial education. But if a boy of fourteen about to enter upon industrial life is in need of training, certainly the boy of twelve needs to have some training in the methods of anticipating the crucial difficulties which he is to encounter when he is two years older. Twelve years of age is the crucial period, physically and morally and intellectually. We cannot do the work of training adolescent youth by waiting until the period is well advanced. In the first place, under our present social system many of these youths will escape from the control and guidance of the educational authorities. In any case we should recognize the fact that intellectually, as well as physically, the period of rapid growth is one of maturing powers which have been gradually developing in an earlier period. The impatience of boys and girls in the seventh and eighth grades with a mere continuance of the elementary curriculum ought long ago to have drawn the attention of teachers to the fact that a new mode of administration is required for these years; and new subject matter is required if instruction is to serve the purpose of bridging over the education of the primary years and making it available as a preparation for entrance into the adolescent mode of thought and action.

The Higher Elementary Grades

To some extent this demand is being met. The mode of organizing the work of the last two years of the elementary school has commonly been different from the mode of organization which appears in the lower grades, but too frequently the subject matter of instruction in the upper grades has not been properly modified to correspond to the changes in the modes of administering this work. Departmental organization has prevailed in the upper years, but the subject matter canvassed by the departmental teachers has been much like the subject matter of the grades below. Furthermore, in some cases the educational device of a review of the earlier work has been adopted as the only means of filling up these last two years of the elementary school. The eighth grade begins very commonly with a review of all that has been done in the lower grades before the small amount of new material permitted in this grade is added to that which has been administered in the first seven years. After a little additional material is given in the eighth grade, the last months of this grade are once more devoted to a careful restudy of all of the earlier work, in order that the students who go into the high school may be sent on with a preparation which will omit nothing of the elements that have been taken up in the elementary school. High-school teachers have very frequently been skeptical even after this careful reviewing, and have commenced the work of the high school with still another review so as to make sure that the work of the eighth grade has been properly done. All of this repetition of matter has disappointed and discouraged the students, so that many of them withdraw in the later years of the elementary school or in the early years of the high school from sheer exhaustion and lack of interest in the repetitious matter which the school offers them.

Reorganization required to adapt School to Adolescents

If instead of this failure on the part of the schools to recognize the oncoming adolescent period we could have a clear recognition of the possibilities of productive work in the seventh and eighth grades, there would be a general and radical change in the content of the course of study and in the method of instruction with a definite view to carrying the children along at a more rapid and efficient rate. The experiment has several times been tried in this country of deliberately reducing the length of the elementary-school course and turning children at an earlier age into the work which has commonly been thought of as belonging to the high school.[1] The difficulty with any such change as this is the prejudice on the part of teachers and parents against any modification of existing practices. Where the experiment has been tried in single subjects it has sometimes failed. For example, there are cases in which arithmetic was given up in the seventh and eighth grades and an attempt made to introduce algebra. Disastrous results have followed in some of these cases, because algebra in its common form is so abstract that children do not succeed in taking it up as readily as they do more concrete work. We have said enough in an earlier chapter about the possibility of modifying mathematics to make it clear that the algebra which is commonly offered in the high school is not suitable material either for the seventh and eighth grades or for the high school itself. If we could have, however, a reformulation of this subject, with emphasis upon those productive elements of the work which would be suitable for first-year high-school students, we might expect also to cure some of the difficulties which have appeared when teachers have simply

[1] "A Seven-year Elementary School," *Elementary School Teacher*, 1913, Vol. XIII, p. 274.

carried back into the seventh and eighth grades in unmodified form a single subject from the high-school curriculum. The cure for such failures is not greater conservatism but greater radicalism. There ought to be a recasting of subjects, and there ought to be a sufficiently general importation of advanced work into the upper grades of the elementary school to put an end to the timidity of both teachers and students. This greater radicalism will not lead to a break in the school organization; it will tend to cure a breach that has been traditional.

In methods of administering studies there has commonly been a very great abruptness in the change from elementary to secondary education. During the elementary period children have been allowed to depend entirely upon their books for assignments; and the recitation has commonly been of a sort which emphasized mere repetition of the work which has been assigned. In the high school the child has found himself suddenly called upon to listen to lectures and to depend upon himself very much more fully for his methods of work and for the arrangement of his own study program. This break between the high school and the elementary school has been a subject of frequent comment. Would it not seem rational, with the break distinctly in mind, to spend some time and energy in the later years of the elementary schools preparing the students for the transition? If instead of conducting a uniform, required course during the last two years of the elementary school the student could be induced to elect certain subjects and to take some degree of responsibility under guidance, would it not be possible to come up to the elective work of the high school with a much better training and preparation for the advantageous acceptance of the new opportunities there offered? If the high-school student is to study independently, are not all of the principles discussed in the last chapter highly important for the seventh and eighth years?

The Junior High-School Movement

These arguments for a change in the character of the organization of the school have been so widely discussed in recent years that many schools have undertaken to organize junior high schools. The difficulty in many cases with these junior high schools is that they do not represent any genuine modification either of the course of study or of the mode of treating children. Very frequently a junior high school is nothing except the seventh and eighth grades of the elementary school carried over into the high-school building, or otherwise designated by a name which would seem to indicate a new type of organization, but which in reality merely continues earlier practices under a new designation. There is absolutely no justification for the use of the term "junior high school" if the type of work carried on in the junior high school is exactly the same as that done in the seventh and eighth grades. If elementary subject matter and elementary methods are employed between twelve and fourteen years of age, then let us recognize the fact that the school is an elementary school.

On the other hand, if the arguments in favor of a new type of organization are sufficiently cogent to make it clear that radical changes ought to be made, then such changes ought to be of a type which will influence the whole educational machinery and will explicitly recognize the importance of the coming period of adolescence.

The Early Years of College are Secondary in Character

The unsolved problems of adolescence are not alone the problems of the upper grades of the elementary school. College courses of the first two years are many of them distinctly secondary in type. Every American college has

elementary courses in languages, history, and science. There is often the most unjustifiable duplication, as in the English courses. This elementary college work is for the most part administered by methods appropriate only to advanced courses. The result is deplorable. Students go from the high school with incipient habits of study and some intellectual interests and encounter a situation in college classes which stimulates little or not at all to earnest endeavor, and gives even to the serious student a minimum of guidance in the art of study. The four-year high-school course is not long enough to carry the burden of secondary education. Students now go to college immature and unable to meet the expectation of those who aim in the college to encourage specialization.

Readjustment is here beset with great difficulties. The colleges of the country are not as free as the high school to make changes in their organization. We may look forward to a period of transition during which the college will struggle to retain its present domain. The high school in the meantime is steadily reaching the point where it will do the work under public control which has up to this time been carried on, for the most part, in the freshman and sophomore years of private institutions. The problem of adolescent training includes such work as has been administered up to this time in the early college classes, and this work must be articulated more closely with the rest of the high-school course.

Reform urgently needed in Interests of Economy

If there were no other motive than economy compelling us to canvass these problems, that motive would be strong enough to bring serious students to a clear consciousness of the fact that the high school has a new problem to work out. As it is now, pupils from twelve to fourteen years of

age waste much time in review. From fourteen to eighteen they get a brief secondary course. From eighteen to twenty they mix secondary work with advanced courses and repeat in part the work of the high school, and wonder what they are to do next. These eight years result in training which every other civilized nation accomplishes in six. It is time that we shook ourselves loose from tradition and an incoördinated scheme of training, and organized a secondary school which shall do fully and efficiently in six years the full work of training adolescents.

The Principle of Individual Differences

There are certain general principles which should guide in bringing about these radical changes. In the first place, the adolescent period is one of clear recognition and emphasis of individual differences. The elementary course is constructed on the general theory that there are certain fundamental forms of knowledge which must be had by every member of society. Everyone must learn to read and write. Everyone must learn the elements of arithmetic, geography, and some of the other fundamental forms of experience. But when we come to the high-school period, it is perfectly clear that individual differences have a right to exhibit themselves, and must be recognized as major considerations in the organization of the school course. We should have a recognition, on the one hand, of industrial interests; and on the other hand, of professional interests. For some students we should emphasize science and its applications; for others, literary studies. There should be such a modification of general courses in history as to appeal not only to those who are going into history as a specialty in the later schools but also to those who are not going on with the study. In short, the work of the secondary school should be organized from the beginning with a

clear recognition of the differences in capacity and interests of the various members of the class. Progress in the different subjects with different individuals ought also to be at different rates. A breaking up of the class, not only with reference to the subject matter to be studied but also with reference to the rate of progress through these subjects, is highly important as a natural concession to individual differences.

The Need of General Courses

As a corollary of the principle of individual differences, or, perhaps better, as a second independent principle, we must emphasize the necessity of giving to each student introductory courses in all the major fields of human experience. Later life will demand specialization; the period of adolescence is one of general training in anticipation of the period of specialization.

Beginning of Specialization

The discussion of this principle of general training in many fields may be coupled with the discussion of a third general principle which is important in secondary education, but is likely to be lost sight of unless it is given explicit attention at the beginning of the course; namely, the principle of continuity of work. It is advantageous for students that they should take a variety of different subjects only when this spreading over many subjects in the curriculum is so administered as to insure that each student shall get some coherent study which will equip him for later concentration. It is now difficult, in the four years which are devoted to the high school, to satisfy both the demand for diversity of subject matter and also the demand for coherence of work. If the student has only four years in the high school and is expected to cover all the major fields

of knowledge, it is evident that his energy will be very largely dissipated. One of the reasons why the languages are having a good deal of difficulty at the present time in maintaining a position in the program is that they demand so large a portion of the high-school students' time that it is felt both by parents and by the students themselves to be irrational to devote so much of a brief high-school course to the study of a single subject. If now the period of secondary training is extended to six years, there is a possibility of combining the two principles of diversity of training and coherence of courses in a very much more advantageous fashion. There will be six years instead of four through which the diversity of interest may be spread. The clear recognition of the principle will lead high-school teachers to present to students certain general courses which general courses will supply the ordinary members of the student body with a view of the various subjects in which they ought to be interested, but in which they are not expected to make exhaustive studies. In the earlier pages of this volume this recommendation was made even in the extreme form, that certain short general courses be organized to give students some notion of languages other than their mother tongue. It has been suggested that general science might serve a very useful purpose in giving a view of the fundamental methods of scientific operation. It has been suggested that mathematics courses be amalgamated in such a way that a student may in one year get some notion of both algebra and geometry. These suggestions are in keeping both with the natural development of the subjects themselves and with the tendencies that are appearing in secondary schools.

At the same time one must emphasize the great importance of giving students a coherent body of courses in some one or two lines. It would be a great mistake to fill up the high-school course with general, summary courses, merely introducing the student to lines of thought and bodies of

material. Parallel with these general courses distributing the student's interests, there should be sequent courses which will concentrate his interests. Undoubtedly the great virtue of the older required course of study in the high school was exactly this, that it concentrated the student's time and energy very definitely upon certain limited subjects, with the result that four years of consecutive work developed an ability of concentration in one field which undoubtedly influenced all of his later study and work. There is very little probability of our returning to the required course of the earlier high school. That has sometimes been suggested by those who are critical of our present mode of organization. The difficulty with the required course was that it designated for each individual student the lines in which he should concentrate. Our elective program has made it clear that we are going to organize our high schools in such a way that concentration will not be required of students in any single predetermined line. Let the student select the lines in which he is interested, but after he has begun work see to it that he follows some lines with sufficient energy and devotion to insure continuous and coherent training. This is not a compromise with the old required course; it is a recognition of the cardinal virtue of that course, and a reformulation of that virtue in terms of the elective organization which has undoubtedly come to stay as a part of our school organization.

To these three psychological principles may be added a fourth general social principle, which has already been amplified in earlier paragraphs; namely, the principle that the duty of a democratic secondary school is not to eliminate students, but to guide them into courses which they can take with advantage. The recognition of this last principle will have the largest influence upon the methods of work of students and teachers, and must therefore be included in any summary of the psychological conditions of high-school work.

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